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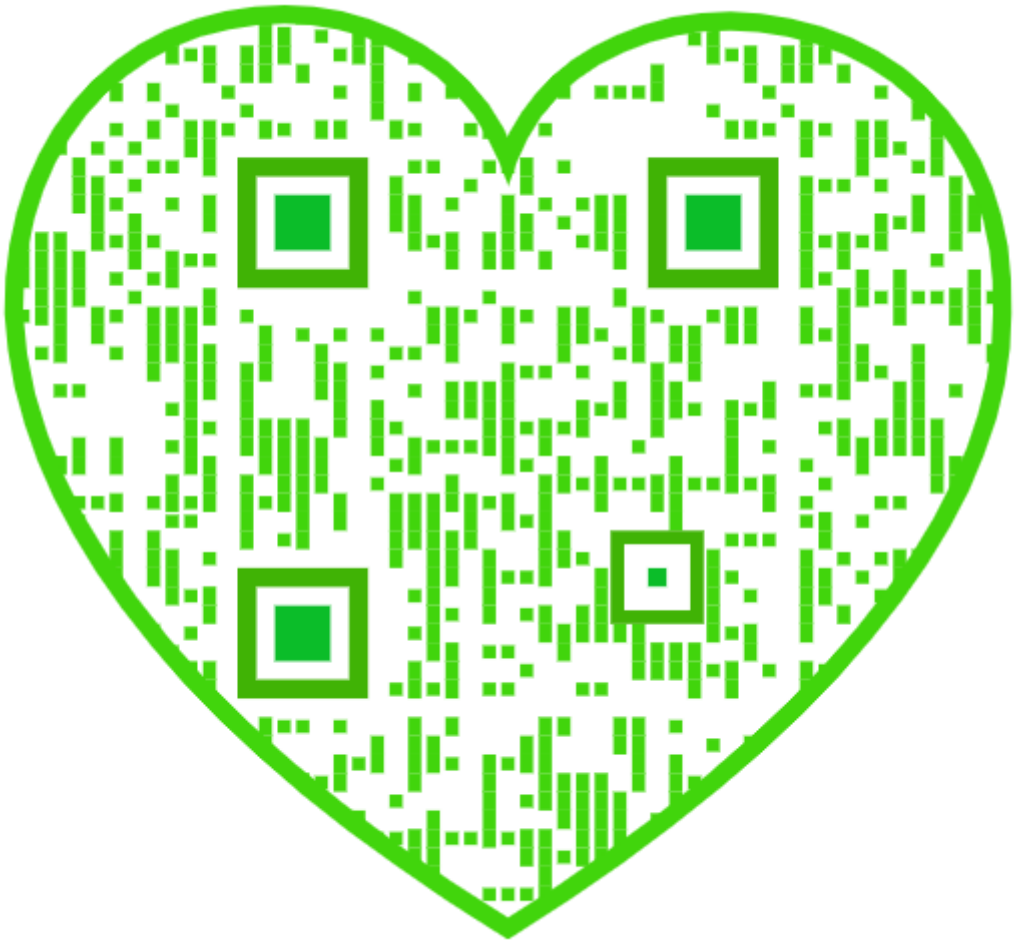
A NEW CLASSIFICATION OF NATURAL AND ARTIFICIAL TEETH

J. LEON WILLIAMS, D.D.S.



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A New Classification of Human Tooth Forms With Special Reference to a New System of Artificial Teeth

J. Leon Williams, D.D.S., L.D.S.

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A NEW CLASSIFICATION OF HUMAN TOOTH FORMS; WITH SPECIAL REFERENCE TO A NEW SYSTEM OF ARTIFICIAL TEETH.

By J. Leon Williams, D.D.S., L.D.S.

"It is only what happens that matters."

Three years ago I presented before this Society the outline of a scheme for a system of artificial teeth, and a plea for a new order of things in dental prosthesis. I had but little material evidence to lay before you in support of the contentions advanced, for that was impossible. But I had something in the nature of a vision, in which I saw an important branch of our professional service redeemed from the low and almost contemptible position it has long remained in. Something of that vision I must have been able to get before you, for the substance of it met with your unqualified approval and you passed a strongly worded resolution giving official expression to that approval and asking the manufacturers to take up the work I had outlined and proceed with it along the lines I had formulated.

Such an undertaking, at that time, must have seemed hazardous to the manufacturer. It called for a very heavy initial outlay. There was nothing in the work that could be patented and no way in which the pioneer in the new field could be protected from the unfair competition which imitation, without initial outlay, would make possible.

But in spite of these unfavorable conditions we were fortunate enough to find a manufacturing company with sufficient faith, courage and enterprise to take up and carry out the work in a liberal spirit; and to-day I come before you again to announce the early completion of our long labors.

The whole scheme which I laid before you is not completed in its entirety, but there is, we believe, quite sufficient evidence to offer of so great an advance in this field as to make the old order forever intolerable, and thus to place upon *you* the obligation to so encourage the manufacturer that he will carry all phases of the work through to its final consummation.

And now, at the very outset of my lecture, I should like to make it perfectly clear that **this system of standardizing tooth forms is not offered to the dental profession as a mere improvement on what has preceded it.** It is not an old building with a redecorated interior and a new facade. It is a new structure throughout. Its foundations, I believe, are well and truly laid on a solid basis of scientific fact, with a superstructure designed in accordance with a principle of unity, without which good art is impossible. And when our work has been carefully examined, when its full scope and the measure of its achievement shall have been clearly seen and understood, I think the universal query will be the one often propounded on the completion of some important undertaking having for its main object a practical benefit to humanity, "Why was this not done before?" The logic and reason of a completed work is so frequently self-evident that we cannot avoid asking that question. But in doing so we overlook the tremendous power of the psychology of habit, the great difficulty in getting outside ourselves for a point of view, and the comforting feeling of ease in following lines of least resistance. It brings no sense of effort or fatigue to take a thing for granted. It is in the overcoming of these psychical conditions that the would-be reformer often finds his greatest task. And that is saying more than a little in this instance, for the material conditions have sometimes presented a formidable front. But the knowledge that every difficulty removed and every obstacle surmounted has contributed something toward placing the finished work on a higher level than it would otherwise have reached is a very gratifying reflection.

In an ancient book in which there are many wise sayings it is written: "To everything there is a season, and a time to every purpose under the heavens;—a time to kill and a time to heal; a time to break down and a time to build up." To-night I shall address myself solely to the former of those two functions. I have to undertake, in the short space of an hour or so, to break down the old system of prosthetic dentistry.[2]

From the standpoint of the reasonableness and force of the proofs at hand, the task seems to me not a difficult one, but I should be a very poor student of human nature if I had not discovered that it is far easier to convince a man's reason than it is to break up the established routine of his bad habits in craftsmanship as in many other things.

[2]Only the first half of this paper, the part devoted to destructive criticism, was read on the date above mentioned. The latter part of the article was read on March 10.

However, I am greatly encouraged in my belief that the bad old customs of practice in dental prosthesis are about to receive a rude shock by my knowledge of the fact that in no country in the world are inferior methods, systems and machines so quickly discarded or "scrapped" the moment their inferiority to something new is demonstrated and established, as here in America. American business men found out long ago that it is the truest economy and the surest way to success to throw away an inferior method of production, or a method which produces an inferior article, the instant better methods are discovered. That policy has made Americans the greatest leaders in the business world. It has sent all the nations of the earth here to learn and copy American methods, and to-day you may find those methods being put into effect in the remotest corners of the world. So strong and vital is this influence of American progress that Guglielmo Ferrero, the distinguished Italian historian, says "it is the one idea that has taken deep hold of the European masses during the last fifty years." It has certainly created a new outlook and a new spirit in the world. It has made men more self-reliant and given them a greater confidence in their own inherent capacity to subdue the stubborn and apparently antagonistic forces of Nature to human will. It is in that American spirit which says, in the language of the people, "The best we can have is none too good," that I have come here to-day to ask you to discard, to throw away, to utterly destroy and obliterate a system of prosthetic dentistry that has existed far too long, and to establish in its place something more in keeping with the reputation for progress and scientific achievement and character that our country enjoys in other fields throughout the world.

Dr. Ebersole, in a stirring and eloquent call, published in the *Dental Summary* last January, warned you that dentistry was not keeping in the van of American progress. If that is true in any degree of dental practice as a whole, then it is most emphatically true of dental prosthesis. And on that point I believe there are no two opinions.

To remedy the present deplorable condition of things in this field the first important step is to find out the cause or causes of this condition. In my judgment, the chief cause is to be found in the false basis of the present methods and theories for the selection of porcelain teeth and it is, as I have indicated, principally with this theme that I shall deal this evening.

I believe that the chief reason why prosthetic dentistry has fallen so low in the estimation of the profession is **that most dentists have an instinctive feeling that with such teeth as have heretofore been supplied, no amount of effort on their part would produce satisfactory scientific and artistic results.** I wish, therefore, to try and make it clear why the present system is weak and poor. I want to point out its imperfections and fallacies, its dogmatic assumptions that have no foundations, its ignorance of scientific facts and artistic principles, so that there may be no qualms of conscience, no shadow of regret in saying good-bye to it. This will take a little more of your time than you are accustomed to give to listening to a paper or lecture. But I ask you to remember that the occasion is a little unusual. You are not often asked to listen to reasons why you should make a complete and radical change in an important branch of practice.

Two great defects have characterized the manufacture of artificial teeth from the date of their invention down to the present time, a conventionalized or generalized tooth form, devoid of definite character, and the absence of any system of classification, or any fundamental principle or central idea on which the work is based. This statement applies with equal force to the shapes of the incisors and the masticating surfaces of the bicuspids and molars.

There are very definite reasons why artificial teeth should have continued to remain, for such a long period in the history of dentistry, of a defective and unnatural character and without systematic arrangement. It was hardly possible to have any satisfactory classification of natural teeth, neither was it possible to have fine, natural, artistic forms of artificial teeth without a knowledge of the primary forms of natural teeth. That statement may sound somewhat curious to you, but I hope to make it quite clear, presently, that **the primary forms of human teeth have, hitherto, not been known.** Like old friends, whom we sometimes meet and pass on the streets when our minds are preoccupied, they have been *seen* and not *recognized.*[3]

But to produce a perfect system of artificial teeth there is required not only an intimate knowledge of all the facts of Nature, but also familiarity with the principles of design through which a harmony of related parts, that is often absent in Nature, may be secured.

[3]Many examples could be adduced to show that long observation does not always result in accurate perception. Herbert Spencer, at different periods in his life, held three distinct opinions about the color of shadows, each one, as he says, "based on years of observation." And his final recognition of what he regarded as the exact truth was due to a suggestion he got while reading a popular work on optics.

This very essential qualification for the production of artificial teeth seems to have been entirely overlooked.

As a matter of fact, no serious attempt has ever before been made to investigate any portion of this field with scientific thoroughness and accuracy. All the honors in dentistry have been reserved for other departments, with the result that many men who have national reputations in what is called operative dentistry, make a mighty poor showing when they turn their hands to dental prosthesis.

Whether or not the reason for this is the one I have suggested, it is, nevertheless, certain that this branch of practice presents a far finer opportunity for the exercise of artistic skill, scientific knowledge and sound judgment than is to be found in any other phase of dentistry. If any one has any doubts on that point I hope he will reserve his final opinion until he has heard the full "argument for the plaintiff."

You will, I think, be able to see more clearly the relation and significance of the facts presented if I state specifically the main objects I have in view in this paper. I shall attempt to destroy all belief in temperamental forms of teeth, for I regard this as one of the most fundamental errors in the present system. **I shall try to show that while there are slight variations in the teeth of different peoples, there is no such thing as racial types of teeth. I hope to convince you that the oft repeated statement that Nature always produces teeth in harmony with face and feature is a mistake due to lack of careful observation. And I expect to prove that it is impossible to produce a scientific and satisfactory system of artificial teeth by simply copying sets of natural teeth.**

Let us begin then, with the subject of temperamental classification of teeth. And let me note at the outset that some of our best writers on dental prosthesis say quite frankly that they make use of this theory for lack of a better.

In his excellent book, recently published, my good friend, Dr. Wilson, of Cleveland, has introduced a brief resume of the theory, but I think I discover evidences that he is not altogether satisfied with it. Other writers, after admitting that there are great variations within the limits of the normal, afterwards say that with few exceptions the forms and contours of the teeth are harmonious with those of the body, but they give us neither principles nor facts on which such a statement is founded.

One author says further that "it is difficult, in some cases, to decide positively to which variety (of temperament) a special case belongs . . . Not infrequently the indications are even contradictory . . . and no rule can be given that will not fail in numerous instances." I submit that a theory of this character is much more likely to mislead than guide the student and beginner, and that it would have been better to drop it altogether in dentistry, as was done in other branches of science long ago. But this course has not been taken, and the theory still has some ardent and dogmatic advocates. I am sure you will agree, therefore, that it is better to subject the claims of this teaching to a thorough critical examination before putting forward the new classification.

Let us first glance at the great, authoritative modern works of reference, to see what they have to say on the subject of temperament.

Our first effort is a little disappointing.

We open the Encyclopaedia Britannica at the place where the word should be, but we do not find it. It is completely ignored. We consult the New American Encyclopaedia of Science and do not fare much better. The word is there, it is true, but used in a sense that connotes nothing of the physical or mental characteristics of human beings. It simply has reference to certain technical matters about *musical instruments.* Gould's Dictionary of Medicine says that the word is spoken of as a vague term or a term vaguely applied. This authority further says that although the original doctrine has long since lost its significance, it is permissible to use it in describing *predisposition to types of mental action*: and that is the manner in which it is sometimes used by good modern writers.[4] Jonathan Hutchinson, F.R.S., with whose work on the teeth you are all familiar, made a careful examination of the claims of the temperamentalists and here is his verdict: "As yet I fear we must say that the labors of the physiognomist and those of the students of temperament have been alike disappointing. Whoever will set himself the task of attempting to classify a given number of individuals according to their temperaments will, I think, soon find himself baffled."

The simple truth of the matter is that this whole theory of temperament has been completely discredited and entirely abandoned by

[4]Dr. E. B. Taylor, F.R.S., author of an important work on Anthropology, says: "Anthropology finds race-differences most clearly in stature and proportions of limbs, conformation of the skull and the brain within, characteristics of features, skin, eyes and hair, peculiarities of constitution, and *mental and moral temperament.*" The italics are mine. Dr. Keane, one of the very greatest authorities in Anthropology, applies the word "temperament" solely to psychical qualities.

all scientific men of standing—except a few of those who rule over the destinies of dentistry. And for them I fear that a mere reference to authorities, however eminent, will hardly be sufficient. We shall have to go a little deeper into the matter, to completely satisfy *them*. But before getting down to the real work of proof, let us have a side-long glance at those pretentious tables of temperamental classifications with their air of exhaustive research and minute discrimination, which figure so prominently in our textbooks on prosthetic dentistry.

You are all familiar with the results of the researches of Dr. Black and Mr. Charles Tomes into the question of comparative hardness or softness of teeth. You know that working quite independently they both reached the conclusion that the variation in the hardness and softness of teeth was a negligible quantity. The differences are so small as to be a matter of no importance. But if we turn to those tables in our textbooks on prosthetic dentistry which profess to give the temperamental characteristics of teeth, we find the so-called lymphatic teeth, and combinations of the lymphatic, bilious and nervous teeth, described as "soft and brittle"; "soft and frail"; "soft and weak"; "soft and sensitive"; "mixture of flinty and chalky"; "soft, weak and chalky," etc., etc.

I shall show you presently that all so-called temperamental characteristics must have arisen in racial characteristics. With that fact in view, the question, "Do those races from which the so-called lymphatic, bilious and nervous temperaments have arisen have teeth that are markedly more soft and frail than the sanguine races?" need only be asked to see the utter absurdity of the whole business stand revealed, even without the classical work of Black and Tomes to prove it.

Then take the indications as to shape and size. We are told that the teeth of a bilo-nervous person are "medium large" and "long and often narrow" in shape, while the nervo-bilious teeth may be "large or small" and "broad or long." Is that the sort of instruction a dental student requires to enable him to produce harmonious relations between tooth form and facial contour? If you were given a blank form of face of a definite size and of the oval type, let us say, and required to describe the character of the features necessary to produce an harmonious whole, would you say that the mouth might be short or long, the nose large or small, the eyes near or widely separated? **In all the wearisome contradictory and irrelevant details of these tables there is never a hint of fundamental principle on which a student could take his stand for the exercise of his taste and judgment.**

Many of you will remember that in the paper which I read here three years ago **I pointed out that there was really no foundation for the theory of temperamental forms of teeth.** I exhibited photographs of individuals of precisely the same temperaments, according to the rules of the theory, but showing teeth widely different in shape. Since then text books on prosthetic dentistry have appeared in which this theory is given a prominent place. But even more significant, perhaps, is the prominence given to this theory in the recently issued catalogues of two of the oldest and most prominent manufacturers of artificial teeth. I say "more significant" because the prominent manufacturers have the best of reasons for making it their business to know the general trend of belief and opinion in the profession.

In the latest catalogue of one of the largest and oldest firms in England we find illustrations of the three sets of teeth in the lower row of Illustration No. 1, and at the bottom of the pages on which they are shown we read—"The dentures illustrated above are *distinctly typical* of the temperaments described by Spurzheim," and then, as though to specially emphasize the statement that these particular teeth *are "distinctly typical,"* they add that "it must be remembered that a pure type is seldom met with, the majority of the cases being combinations of the features of more than one temperament." The temperaments represented in the three dentures I have selected are supposed to be the "sanguine," the "bilious" and the "nervous." I will ask you to look very closely at the central incisors, always the most characteristic teeth in any given set, and see if you can detect the very least typical difference. **The teeth are not only of one type, but they are very nearly indistinguishable as to form and size.** Except as to color, there is not a ghost of a reason why these sets should not all change places.

A representative American firm has also published illustrations of teeth designed for the pure temperaments, as shown in the upper row of illustration No. 1.

Please compare the corresponding types of the two manufacturers. No comment from me is necessary, and I will make none, except to say that these teeth are not made by firms whose reputation is ever called in question. They are firms which are rightly and justly jealous of the high reputation they have honorably earned. But can you look at the specimens of these two companies, each claiming its own work as typical, and each so widely different from the other as to make comparison positively grotesque, without thinking that **it is about time we heard the last of temperamental classification of teeth;** that

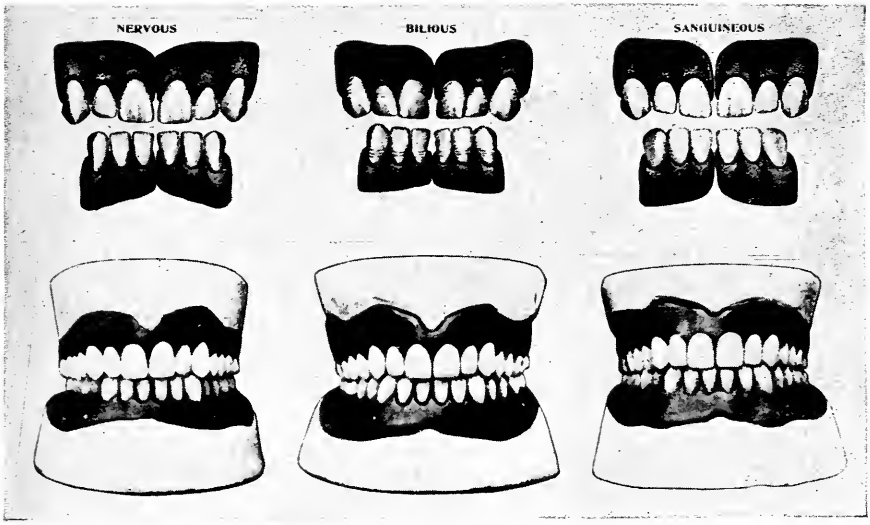

Illustration No. 1

Lower row, three sets of teeth from a well-known English manufacturer supposed to be typical of the temperaments described by Spinzheim. All three sets are of one type, but very nearly of one form of that type.

The upper row shows three sets made for these same temperaments by a long-established American manufacturer. Each form is so different from the form of the English manufacturer for the same temperament as to make comparison difficult.

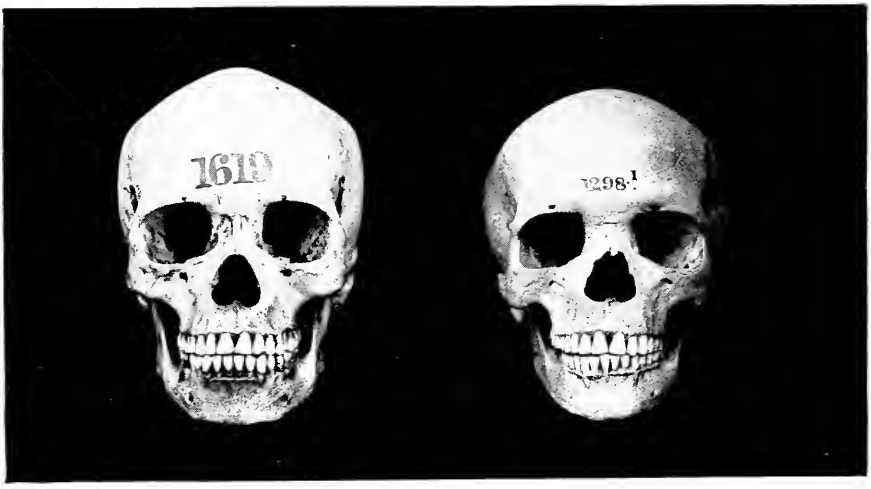

Illustration No. 2

Two skulls of unlike form with teeth identical in type and size. No relation between form or size of skull and the form or size of teeth.

it is about time we began looking for something a little more scientific as a basis for tooth form, **and also, if I may say so, about time that some one designated and officially indorsed by the profession, to express their views and wishes, took a hand in the designing of artificial teeth?**

There are several phases of this theory of temperament, but they all overlap more or less. This may sometimes cause an unavoidable appearance of redundance in the proofs brought against these different phases. And I fear that this fault of redundance, or perhaps it might more correctly be called repetition, will appear more or less throughout the paper. There is so much that is entirely new and foreign to all former teaching in my paper, that it has seemed to me often necessary to present the same facts from more than one point of view.

One writer on the subject of temperament says: "In these temperamental differences, no single sign is more significant than is to be found in the physical characteristics of the teeth—their size, shape, color, density and alignment being as much an index as is the distinctive complexion, the color of the eyes, hair, etc." A little farther down the page it is said: "The law of harmony thus found in Nature between the teeth and other physical characteristics requires—" etc., etc. And once more: "The careful observation and recording of these co-relations would go far toward making prosthetic dentistry an exact science." Here we have three variations of an assumption that Nature always produces teeth that in form and size are in perfect harmony with the face and the individual features of the face. We often meet this assumption in our text books and in magazine articles. On what is it founded?

I have never heard anyone assert that all the other features of every human face were in perfect harmony. The most of us have seen many faces on which we would pass the observation of old Omar Khayyam—if the "sorry scheme of things" were entrusted to us "would we not shatter it to bits and then remould it nearer to our heart's desire?" The great teacher of science, Haeckel, is almost brutal in his remarks on this point. He says in his "Evolution of Man": "If we compare the face of the long-nosed ape with that of abnormally ape-like human beings, the former will be admitted to represent a higher stage of development. There are still people among us who look especially to the face for the 'image of God in man.' The long-nosed ape would have more claim to this than some human individuals one meets." Is there anything more evident to us as we walk up and down the streets or stand in any place where our fellow mortals congregate, than the

incongruities of Nature? Even the most fortunate would probably not be willing to give an absolutely unqualified receipt in full to Nature on taking a critical survey of himself in his mirror. **Why, then, should we assume that Nature always produces teeth in perfect harmony with face and features?** Why should they be an exception to the almost universal rule to the contrary in other particulars? The only explanation I can suggest for this strange inconsistency is that an acceptance of the temperamental theory made it necessary. It is, in fact, a phase of that theory. And when we have once given our unreserved consent to a theory it is astounding how completely oblivious we become to the most obvious facts. Let me put a few of the facts bearing on this question before you. Here is a photograph of two skulls (Illustration No. 2). You will observe that the difference in general contour is very marked. But the teeth, you see, are identical in size and type. If either set is in perfect harmony with size and contour of face, the other set cannot possibly be so.

Here are two more (Illustration No. 3), a very wide and a very narrow skull. Think what a striking difference there must have been in the facial contour of the two individuals those skulls represent. But you see the widest and shortest teeth are in the long, narrow skull. And here (Illustration No. 4) are two more from the Andaman Islands—both skulls from the same race. Here again the smaller skull has the larger teeth. Note also that they are not of a different type.

Here we have four skulls (Illustration No. 5) so nearly alike in size and contour that a single set of teeth would be just as suitable for one as another of them, but look at the difference in the natural teeth. At least three of those must be examples of disharmony. A glance at the teeth is sufficient to demonstrate the mistakes of Nature. I could take up the whole evening in showing you examples of this sort, but as further proof on this point will appear incidentally when I am considering other phases of my subject, I will not dwell longer on it now. Unless someone can advance good and satisfactory reasons for believing that Nature is more solicitous about the harmonious relations of our dental organs with other features than she is about those of our eyes, ears or noses, we will conclude that the subject is always open to the intelligent criticism of an artist in teeth.

The advocates of the temperamental theory always assume that when a man and a woman of opposite temperaments mate, the offspring will be a blend of the two temperaments. To a certain limited extent this may sometimes be the case, but more frequently we see a juxtaposition, so to say, of the salient features of both parents. This

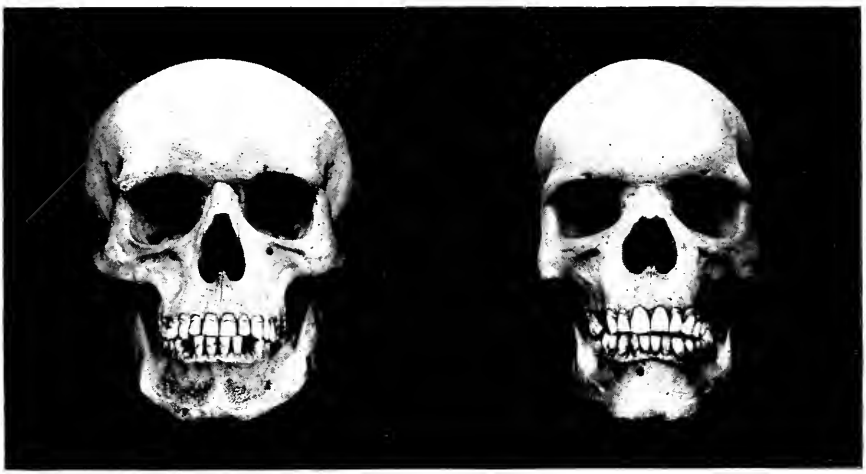

Illustration No. 3. The widest and shortest teeth are in the narrow skull

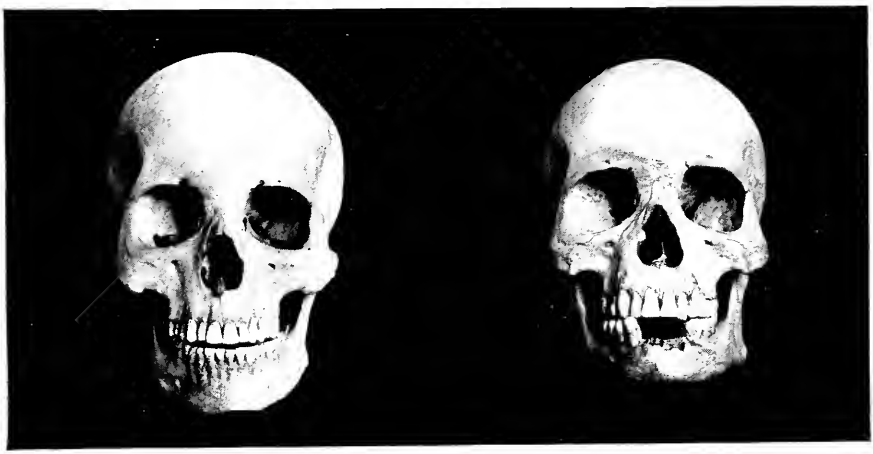

Illustration No. 4. Two skulls from the Andaman Islands. The smaller skull has the larger teeth and of different type, than the other

might have been known either from observation or from a knowledge of the more recent researches in heredity.

The works of Mendel, Weissman, Galton, Thomson, Bateson and others have made it clear that certain characters are dominant in one parent and other characters in the other. One child may inherit the general facial peculiarities of the father, and the complexion, color of eyes and hair, and the teeth of the mother. In another child these conditions may be reversed. In Sicily, that old battle ground of the races, where the blood of the blue-eyed, fair-haired followers of Norman Roger has mingled with that of the Arabs, I have often seen just such effects of this crossing of types as I have mentioned, and one may see in Ireland people with black hair, dark skin and blue eyes.[5]

What is the value of the temperamental theory of tooth form in instances like these?

And now, consider for a moment the basis on which the whole theory rests. It is founded on the idea of four groups or classes of individuals called the pure temperamental types and known as the sanguine, the nervous, the bilious and the lymphatic, in accordance with the alleged dominance of the physiological functioning of the blood, the nerves, the bile, or the lymph. What do the advocates of this theory mean by the dominance of these systems? Obviously but one thing can be meant, and that is that the action of the heart or the liver or the lymphatic system or the nervous system is stronger or dominant in the individuals characterized by these terms. People of the sanguine temperament should show a stronger action of the heart, those of the bilious temperament greater activity of the liver and people of the nervous temperament should be distinguished by greater intellectual achievements and brain power generally.

Well, I have a large collection of photographs of some of the most eminent persons of this country and Europe and **I find that all forms of faces and physical characteristics are included among the ablest and most intellectual people of the world.**

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[5]Broca and Thurnam, in the Memoirs of the Anthropological Society, describe a group of sixteen ancient skulls, nearly all perfect, found in France at Nogent-les-Vierges. Three of them are described as the dolichocephalic skulls of Aryan stock, eight as the brachycephalic of Mongolian origin and five as a cross of the two. These latter had the high, narrow forehead of the long headed race, while the middle and occipital regions of the skulls had the width and fulness of the round headed race.

Thomson, in his fine work, "Heredity," says: "A white man of considerable intellectual ability marries a negro woman of great physical beauty and strength: the result may be—has been a mulatto, who inherits some of his father's intellectual virtue and some of his mother's physical strength." Again, "If a tall variety of (sweet) pea be crossed with a dwarf, *all* the offspring are *tall*, and among *their* offspring in turn three-fourths are tall and one-fourth dwarf, *but none between the two.*" The italics are mine.

Thomson further says, when speaking of Mendel's law: "Experimental work has driven home the conception of unit characters . . . that are inherited independently.

But it may be pertinent to ask who has ever made any experiments of a severely scientific character to prove that the action of the heart is stronger in so-called sanguine persons, or the liver more active in bilious persons, or the brain larger in the alleged nervous temperament? Who has ever conducted such experiments to prove anything about temperament as indicative of physical characteristics?

Who has ever determined the temperament of a negro or an Arab? Are the individuals of all races except Europeans, alike in their physical and psychical characters? If not, what physical peculiarities in a Chinaman, a native of Australia or a Hindoo correspond to those alleged to be indicative of the nervo-sanguine temperament in an American?

Who has ever got together, even a dozen people of one temperament, selecting them by their alleged physical temperamental peculiarities *without* looking at their teeth, and then examined the teeth to see if they were all alike or of one type?

If that simple experiment had ever been made it would have been seen that this pretentious structure (the temperamental theory) **is as frail as a house of cards and as empty as a soap bubble.** A recent writer in the Edinburgh *Review* says: "The greatest discovery ever made in philosophy was that the way to discover whether a thing is present is to *look and see.* It was proclaimed by Aristotle in the ancient world and by Francis Bacon in the modern world." The extent to which that simple rule is neglected is one of the astounding things of life.

And now let me lay before you the final and crushing proofs of the utter futility and fallacy of this theory.

What is the origin of those physical characteristics that are called temperamental? You have on the screen pictures from life in which are represented the three great races from which it is believed all the modern peoples of the earth have arisen. The black race is represented by the South African Medicine Man; the yellow Mongolian race by the group of Chinese; and the Caucasian peoples by the blue-eyed Norwegian bride. The three distinct types of skulls, long, broad and medium, most characteristic of distinct races, are also represented in these three types.

Away back in neolithic, or even in paleolithic times, there were two races in Europe—the long-headed or dolichocephalic type, and the broad or round heads, the brachycephalic type.[6]

[6]Professor Duckworth, of Cambridge, England, writing of the Krapina skull, says: "It is shown that early paleolithic man presents examples of skulls both of brachy-cephalic and dolicho-cephalic proportions."

The Caucasian race is, possibly, a later evolutionary development.

The portraits I have just shown may be taken as the modern representatives of those ancient races. Broadly speaking, the fair races, and, to a large extent, the yellow races, are found in Northern and Central Europe and Asia, while the darker races occupy the Equatorial and southern regions. From the mingling of those light and dark races, the working of the principle of variation, and the modifying effects of climate and general environment, there has arisen all the racial or temperamental characters that the widely varied inhabitants of the earth exhibit.

There are many theories and there is much speculation about these ancient races, but all theories and all known facts are in agreement on the point of the meeting and mixing of dolichocephalic and brachycephalic races in Europe in prehistoric times.

It is a very fascinating theme, but we cannot dwell upon it now, and the main facts are all that is necessary to our purpose in tracing the origin of temperament. What we really know beyond controversy is that **everything denoted by the term temperament must have arisen in or originated from race.** We can see clearly enough that most of the peculiarities described as sanguine must have been transmitted by the Caucasian race, while the bilious features were inherited from the dark races, and the Mongols have most of the distinctive traits called "lymphatic."

If we now open a book such as Stewart's on "Our Temperaments," the latest and best work on the subject that I have seen, and find portraits of such individuals as those now shown on the screen, we know that the physical or so-called temperamental characters which they present did not arise spontaneously and without cause. The immediate ancestors of that man with red hair and blue eyes were not natives of Africa. The parents of that swarthy individual with dark complexion and black eyes and hair were not full blooded Swedes or Norwegians; and we can predict with reasonable certainty that there is a Mongolian strain in that so-called lymphatic person with the pipe who looks so comfortable and altogether satisfied with himself. In other words, we can discover no special trait or characteristic in these individuals who are supposed to be representative of the different temperaments, that is not even more clearly shown in the representatives of the great races which were exhibited a moment ago. In fact, the only difference is that these temperamental types are further removed, by crossing, from their racial origin. **The real significance of the term "pure temperamental" is that the individual instance**

shows, in a mixed race, an unusual reversion to the dominant racial type. The mixed temperaments are simply the result of the mingling of the blood of different races, somewhat modified, in the event of migration, by changed environment.

If, therefore, there is such a thing as a sanguine type of tooth or a bilious type of tooth, they must have originated in the sanguine and bilious races. If there are special, characteristic, temperamental forms of teeth, there must have been racial forms from which they were derived. There is no possibility of evading the logic of that conclusion. And I think it has always been assumed by our profession that there *are* racial forms of teeth. I think you will find many references in our literature to this supposed fact.

Now, a racial form of tooth must mean a distinctive form peculiar to a race. But if I am able to show you that there is no such thing as a racial form of tooth, if I can prove beyond all possibility of doubt that there are certain primary forms of teeth which are, in their general type characteristics, common to all races, light and dark, ancient and modern, savage and civilized, then I submit that even the unreasonable minority will have to agree that all belief in a temperamental type of tooth must go.

There are certain differences as to size and small differences in proportion of width to length in teeth of the same general type in different races, but **as to essential differences in type, there are none.**

When I began my work of investigating the forms of human teeth at the Royal College of Surgeons, in London, it was with the belief that there were racial types of teeth. I had no doubt about it. I had so often seen statements to that effect that I simply assumed that it was true.[7] And when I did not succeed in finding any form of tooth characteristic of race I concluded that my failure was due to race admixture. Even with the most sincere desire and the strongest determination to find out the truth, still what we have been taught, our inherited beliefs, will continue to haunt us for a long time, like unhappy ghosts who see their continued existence endangered and fight for it with all their might. I pursued this study for nearly a year, and during that time I was accumulating a great store of individual human teeth. The largest lot that reached me from any one source

[7] I had particularly expected to find strongly marked differences between the teeth of the dolichocephalic skulls of the peoples descended from the Aryan stock and those of the brachycephalic skulls representing the ancient Mongolian races. I also expected to find that the teeth of remote insular groups, such as the Andamans, Fijians and Tasmanians, would present strongly marked typal features.

came from the University of Pittsburgh by the kindness of Professor Friesell. But for this interest and generous action on his part I doubt if the discovery I am about to lay before you would have been made. One day it occurred to me that it would be a good idea to begin sorting and arranging the central incisors into groups. (I had long seen that these were the most characteristic of human teeth.) As I proceeded in the work it became evident, after a time, that I was accumulating *three* very strongly marked groups with a larger number partaking more or less of the combined features of those three groups, but generally with the features of one or other of the three groups dominant in every individual tooth. When I had finished arranging my incisors in this way I again went to the Museum of the Royal College of Surgeons to see what light this discovery would throw on further study there. **I was more than a little surprised to find these three types of teeth in almost every group of skulls which contained a dozen, or even less, with the incisor teeth intact.** My long search for something fundamental had been rewarded. I had at last got what I was after—the key to tooth form. All along I had seen that there were different types of teeth in all the different races, but the co-relation of these different forms had never struck me until I went there with the knowledge of what to look for. That is generally the way with all discovery. We walk unsuspectingly over gold mines and oil wells if we do not know how to look for them. **When I saw clearly that these three types of teeth existed in all races, I knew instantly that I had got Nature's secret of design in human teeth,** and I knew that it would now be possible to beat her in her own work; for Nature, working more or less blindly, makes endless mistakes, as I have previously indicated, while we, working intelligently, can avoid those mistakes. **I saw that the existence of three types of teeth was the fundamental fact in human tooth form and that every conceivable form of human tooth could be evolved from those three types,** and I knew that it would be possible to design beautiful and anatomically correct forms of teeth if I ever saw a human tooth again.

Let us now examine in detail the proofs of the statements that Nature produced three typal forms of teeth in all races and modeled all teeth upon these three. You have on the screen a photograph (Illustration No. 6) representing a small but representative selection of the three primary forms or types of human teeth. **In all reference to them they will be designated as Class I, II, and III.** Class I is characterized by the parallel or nearly parallel lines which represent the proximal

surfaces of these teeth for half or more than half of their length from their incisal edges. In Class II these lines converge so markedly that they would meet in most instances, at a point near the end of the root. These converging lines are sometimes nearly straight, but usually there is a very slight convexity of the mesio-proximal surface and a slight concavity of the distal surface. Class III, which I regard as the most beautiful form of human teeth, and which has rarely if ever before been used as a model for artificial teeth, is characterized by a delicate double-curved line on its disto-proximal surface and sometimes, though less frequently, on the mesial surface. All of the surfaces and angles of teeth of this class are more rounded and graceful than in either of the other two classes. The specimens shown in this photograph represent the most severe or typal shapes of what I call the primitive forms of human teeth. My reason for the use of the word "primitive" will appear later. **All of the other teeth in any given set partake of the features of the central incisors but to a much less marked degree.** But in this respect the natural teeth of a given set are not always in harmony. The crossing of races or some other cause often disturbs the perfect harmony of line of the different teeth in a set, and you may sometimes find centrals of one class and laterals and canines of another. But usually the harmony is more or less perfectly preserved. In designing artificial teeth we can, of course, *always* maintain a proper harmony throughout and thus improve on Nature. The succeeding photographs will show you laterals (Illustration No. 7) and canines arranged in the order of the three classes. As I have intimated, the class characteristics are not so marked in these teeth as in the centrals, but you will have no difficulty in seeing in any of the groups something of the special features of each type. In this photograph you see the effects of crossing the types. There is more or less blending of the primitive forms, although in nearly every instance the dominance of one type or another can be perceived. Probably the majority of teeth in all mixed races are of this character.

We will now pass to an examination of the teeth of some of the more important civilized and savage races of ancient and modern times, in which I shall show you that the three types or classes of teeth I have illustrated and described are to be seen in the skulls of all these otherwise widely divergent peoples. In this first exhibit, the skulls will all be shown in groups of three, thus presenting in one view the three primitive forms of teeth in each race. We will begin with three skulls from a savage race of to-day—the Sandwich Islanders

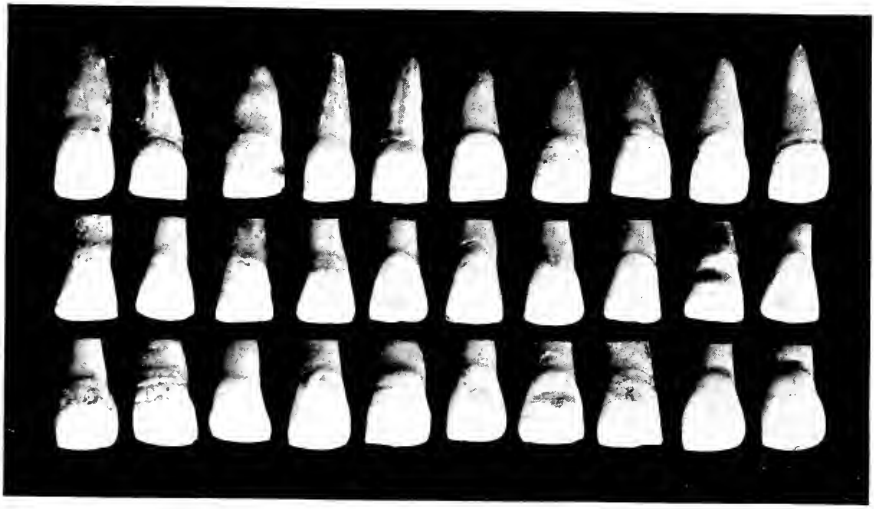


Illustration No. 6
Three classes of centrals. Class I upper row; Class II middle row; Class III lower row

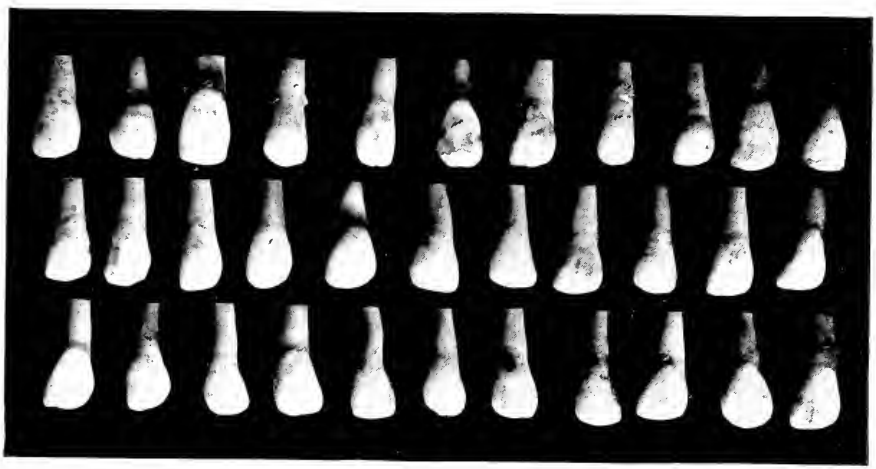


Illustration No. 7. Three classes of laterals. Arranged like centrals above

(Illustration No. 8). The shape of the skulls differ markedly, but this difference in skull shape has no necessary relation to the different forms of teeth. We have here the three primary forms of human teeth very clearly shown. We have the square tooth with parallel sides in skull No. 1, the pyramidal shaped tooth with its converging lines in No. 2, and an ideal specimen of Class III, with its beautiful curves in skull No. 3.

As you would expect, not all of the teeth in the different groups of skulls which I shall exhibit are such perfect examples of the severer forms of the three classes. Probably perfect examples could always be found if one had a sufficiently large number of skulls at command. The surprising thing is that even in a small collection of skulls, often less than a dozen, I have always been able to find fairly good representatives of the three classes, but I believe that the more severe typal forms are more frequently found in those races in which there has been the least crossing.

The next view* is of three Javanese skulls.[8] Here the centrals in Class III have been slightly modified toward the oval form: Class II is well represented by the pyramidal shaped teeth in skull No. 2, and No. 1 shows a very good example of Class I.

Here we have three skulls from another ancient civilized race—the Chinese. No. 1 shows a slightly modified form of the typal tooth, but Nos. 2 and 3 are excellent representatives of their respective classes.

The next group shows two skulls of the modern German. I was unable, in the small collection of skulls at my command, to find a good example of No. 3 in this series. It should be said that the photographs, in many instances, do not show the characteristics of the different forms of teeth as clearly as they would be seen in handling the skulls.

Three modern Greek skulls are shown in this view—1 and 2—very good examples of their class, No. 3 somewhat modified in the direction of 2.

Skulls of modern Hindoos—all excellent specimens of their respective types.

Three strongly marked forms of Patagonian teeth—No. 1 very slightly modified toward the oval shape; No. 2 typical and No. 3 an interesting modification in which the line of double curve appears on both mesial and distal surface.

*It is not possible to reproduce here all the slides shown.

[8]I do not think that these skulls represent the true aboriginal natives of Java. They are probably those of a mixed race.

A group from the New Hebrides. Nos. 2 and 3 are perfect examples of their classes, while No. 1 is slightly modified in the direction of Class III. Notice the wide divergence in shape of these skulls.

These are three Spanish skulls. I had a rather poor collection to select from in this group. But they are interesting in their way. They all represent modifications of the three primitive forms of teeth and might be called secondary types with the primary form dominant in each specimen. No. 3 is especially interesting as it represents a form of tooth of decided character frequently met with. The converging lines of the type are somewhat rounded or curved, the mesial line always more sloping than the distal. There is nearly always slight overlapping with this form of central.

French skulls. Classes II and III well represented. Class I shows a coarse modification of the typal form.

These three from the West coast of Africa—all fine characteristic examples, although No. 3 is somewhat marred by the filing of the centrals.

Three specimens from Italy. Nos. 1 and 3 typical. No. 2 modified.

A group from the Fiji Islands (Illustration No. 9). Please observe that when the teeth are not all good examples of the primary forms of their class, yet the variation in form is so great as to completely upset the theory of a racial type of tooth.

Two Kaffir skulls. Perfect examples of classes. The next two and three groups of skulls are, in some ways, the most interesting in the entire collection shown you to-night. The natives of Australia (Illustration No. 10), Tasmania (Illustration No. 11) and New South Wales represent the lowest type of human beings of modern times. The skulls of these savages have many points of resemblance to the Anthropoid Apes. Here, if anywhere, you might expect to find a racial form of tooth. But just observe the difference in the shape of these skulls and teeth. With the exception of the teeth of the ancient Egyptians, these low Australian savages exhibit the characteristics of the three primitive forms or types of teeth more clearly than any others in the groups I have shown. No. 3 is, I believe, regarded as one of the greatest anatomical treasures of the Museum of the Royal College of Surgeons. It probably shows more intimate relationship with the Anthropoid Apes than any other modern skull. It was received from Australia just as I was finishing this work of investigation and was photographed for the first time for me.

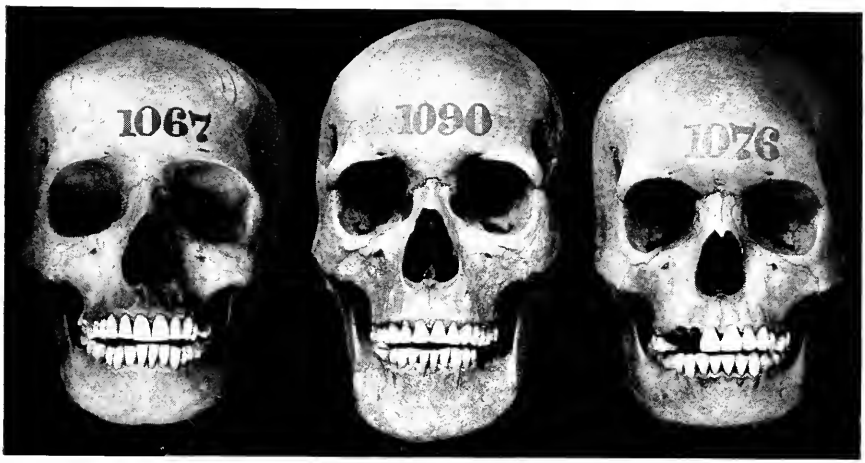


Illustration No. 8. Sandwich Islanders, showing three classes of teeth
In all the following illustrations, Class I is shown on the left and Class III on the right

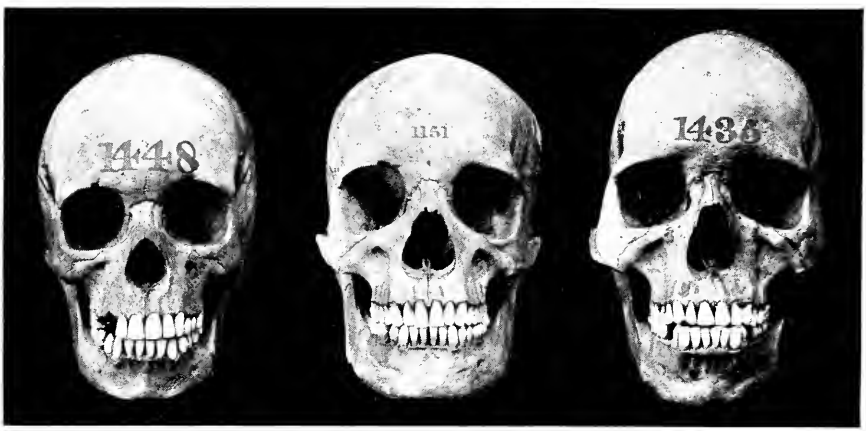


Illustration No. 9. Fiji Islanders—varying tooth forms in same race

The last group in this series that I shall show you (Illustration No. 12) is from that very interesting ancient race, the Egyptians of the III and IV dynasties—a period dating more than 2,000 years before Moses led the Children of Israel out of Egypt. We are back in the Bronze Age at the dawn of what we call civilization, the time of the Troy of the Iliad and before the Great Pyramid was built. It was a piece of great good fortune to have found three such perfect skulls from this far distant era, showing so perfectly the three primary types of teeth. They are each ideal specimens of their class. The teeth in skull No. 1 answer perfectly to the description given in our text books of the sanguine type of tooth, but I believe all authorities are agreed that those ancient Egyptians did not have light hair or blue eyes or a ruddy, light skin. There is evidently a mistake somewhere—perhaps it is the fault of the Egyptians. But the forms of teeth shown in the other two skulls have never been observed by any advocate of the temperamental theory of classification. New temperaments will have to be invented for them.

Suppose the teeth in all three of these skulls had been, as might easily have happened, of type I, a strong tooth full of character. Would it not have been said that here was the typical racial tooth form of the ancient Egyptians? This mistake concerning racial types of teeth has grown out of insufficient critical observation.

I think a little diversion from our main theme, just to relieve the mental tension for a moment, may be acceptable. The most of you probably know that these ancient Egyptian kings had what you might call supplementary names—a sacred name, and also, at least, sometimes, a name taken or given them for some accomplishment and characteristic quality. Now the name of one of the kings of the period represented by these skulls was Sneferu or Snefru. According to one eminent authority the English interpretation of his sacred name was "he who makes good." That expression, you see, is not quite so modern as you may have thought it. And Snefru also had another name bestowed upon him for his prowess in dealing with his enemies. He was known as "the wielder of the big stick"—that expression, too, was not invented yesterday. To prove to you that I am not romancing in this matter I show you a picture of Snefru that is sculptured on the rock walls of the Wady-Maghara near Sinai. There he stands, club in hand, over his fallen foe.

To exhibit in another striking way how teeth of the different types or classes run through all the widely divergent races, I have arranged a few photographs in pairs. The full meaning of what I have to show you will be more vividly presented if I exhibit before each group of teeth, portraits of individuals of the race represented by the skulls showing the teeth. You will thus have in mind at the moment a clear picture of the wide divergence of races in which there is a substantial identity of tooth form.*

And I may as well mention right here that the practical significance of these facts is that they demonstrate and prove that **a system of artificial teeth designed with a knowledge of all the facts about the human teeth is equally suitable for all the races of the earth.** It covers the whole field and that has never been done before.

Our first group is a native of the New Hebrides and a modern Spaniard. At first thought it seems almost incredible that any two individuals of races so far apart in racial characters should have teeth that are practically identical. But the two skulls now shown on the screen prove to you that such is the fact. The centrals and laterals in both are of precisely the same type.

We have shown here a Hindoo and a Javanese as widely divergent in outward appearance as the Spaniard and the New Hebridean. But when we look at the skulls of representatives of these two races we find again identity of tooth form. The teeth of the Javanese are slightly worn, but they are otherwise the same in form and size.

In this view we have a native Australian and a woman of Germany. It is not necessary to call attention to the striking contrast of these faces.

But what about the teeth in these two examples? You see a striking difference in the size and form of the skull, but the teeth are identical in type—both being fine specimens of Class II.

A modern Chinese and a Patagonian.

Here also the teeth in both skulls are of Class II, but in this instance those of the Patagonian are slightly larger, the laterals markedly so.

In these two portraits we probably have as strong a contrast in physiognomy as could be found in any two human races that have ever inhabited our earth. In looking at this portrait of one of the last of the Tasmanians, a race that has only recently become extinct, one cannot fail to be struck with the striking resemblance of the nose and mouth to those same features in the chimpanzee.

*It is impossible to here reproduce these photographs of individuals.

Illustration No. 10. Natives of Australia

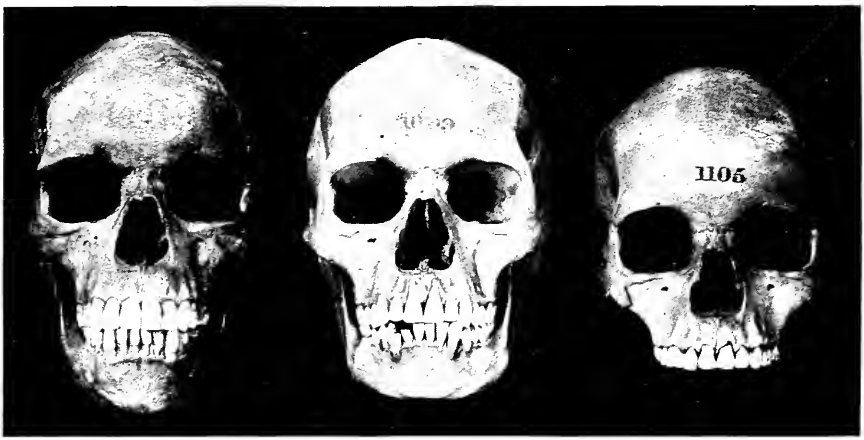


Illustration No. 11. Natives of Tasmania

Illustration No. 12. Ancient Egyptians, showing three primary types of tooth forms

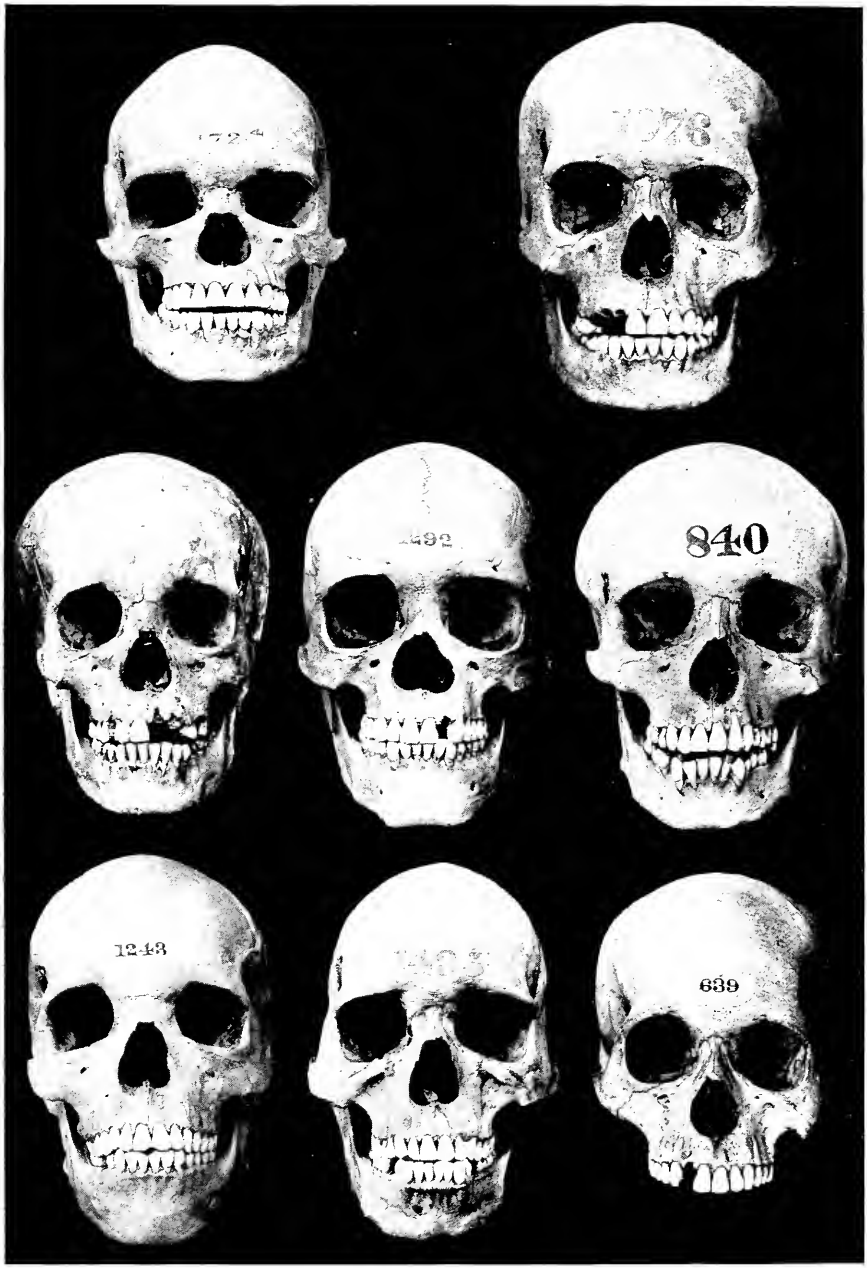


Illustration No. 13

Eight skulls of unlike size and form. All exhibit teeth of Class III. The form and size of the teeth bear no relation to the form or size of the skull.

Nationalities from left to right are:

Australian, Sandwich Islander, Ancient Egyptian, Kaffir, Chinese, African Savage, New Hebridean, Hindoo.

But when we look at the skulls from these two races we see that in the teeth all contrast has disappeared. Here, indeed, we have the one physical touch of Nature that makes the whole world not only akin, but of one family. I shall have time to show you but one more illustration of the identity of tooth form in different races, but in this group I will give three examples—a Kaffir, an Egyptian and a native of the Sandwich Islands.

You see a striking difference in size and shape of skull, but identity in type of tooth, and but very little difference in size.

Let me now call your attention to two views which present a still stronger proof of the fallacy of the racial type theory.

You have on the screen a photograph of eight skulls (Illustration No. 13), representing eight different races as different in physiognomy, shape and size of skull and general race characters as it is possible to find. The central incisors are all of one type—Class III—the form of tooth that has never before been observed. In this next view you have nine more skulls (Illustration No. 14), all from different races, and in these you have another distinct type of tooth, that of Class I with slight variations, and this form also, you see is common to all the races.

While the view of a considerable number of skulls is before you I will once more ask you to note the fact mentioned several times, during the course of this lecture, that Nature does not always produce a definite type of tooth for any given form of skull.

During life, the individuals which these skulls represent must have presented a great variety of facial contours. But observe how many of the central incisors in these widely varying skulls are alike or nearly so. Look at that upper row of four skulls. The teeth are identical in type and nearly so in size. But what a contrast in the skulls, especially in 1448 and 398, and again you see the smaller skull has slightly larger teeth.

Some of you may be thinking that I specially selected these specimens from a very large collection of skulls. But I did not; I took what I already had in hand for other purposes. They are simply different groupings of those which were first shown on the screen.

Again I say the proof that Nature produces no perfect harmonies of relationship in the different parts of organisms is to be seen on every hand. It is before our eyes all the time.

In bringing forward so many of these contradictions of Nature, I may seem to be introducing an unnecessary confusion. But what I am really trying to do is to bring order out of confusion. And in any

event I think it is always much better to know and face all of the important facts in any problem, but I hope no one will take the demonstrations and facts I have just presented as warranting the conclusion that natural teeth are always so imperfectly adapted to face and features, that this relationship may be neglected. That would be as far from the truth as the assumption that Nature always produces a perfect harmony between teeth and face. The important point which contains the gist of the whole matter is simply this: there is such a considerable minority of cases in all mixed races, especially in all widely divergent races in which crossing has recently occurred, in which there is more or less disharmony in the relation of features, that **it would be a disastrous mistake either to found a system of artificial teeth on the assumption that all natural teeth are in harmony with the organism, or to conclude that in edentulous cases no improvement over the natural teeth which the patient had is ever possible.**

More than that, I will say that anyone who will take the trouble to examine and compare forty or fifty skulls from almost any race will be forced to the conclusion that if he wishes to follow Nature blindly in the matter of adapting teeth to facial contour he has a fairly wide range of choice in making his selection. It would probably express an important truth to say that Nature seems to be always striving to reach or realize harmony, but rarely achieving a perfect success, and sometimes going very wide of the mark. The great variety of inconsistencies in Nature emphasizes in a most striking manner the paramount importance of finding some fixed principle of harmony between tooth form and facial contour. **Art must supply us with that which Nature has failed to give us.** What we have to do is to study closely the majority of instances in which an approximation to harmony is seen, and from the knowledge thus gained to deduce the general principles on which the highest possible degree of success may be based. No clear, definite statement of such principles is to be found anywhere in our literature.

The one important fact we have established up to this point is that there are three types of teeth common to all races.

I have no need to labor this point of identity of tooth form in different races or to press for conclusions in the least, beyond what the facts will fully warrant, but I submit that I have destroyed the last vestige of a belief in a racial type of tooth. And along with the passing of that belief there must disappear also the theory of a temperamental type of tooth. My summary of the whole matter is this:

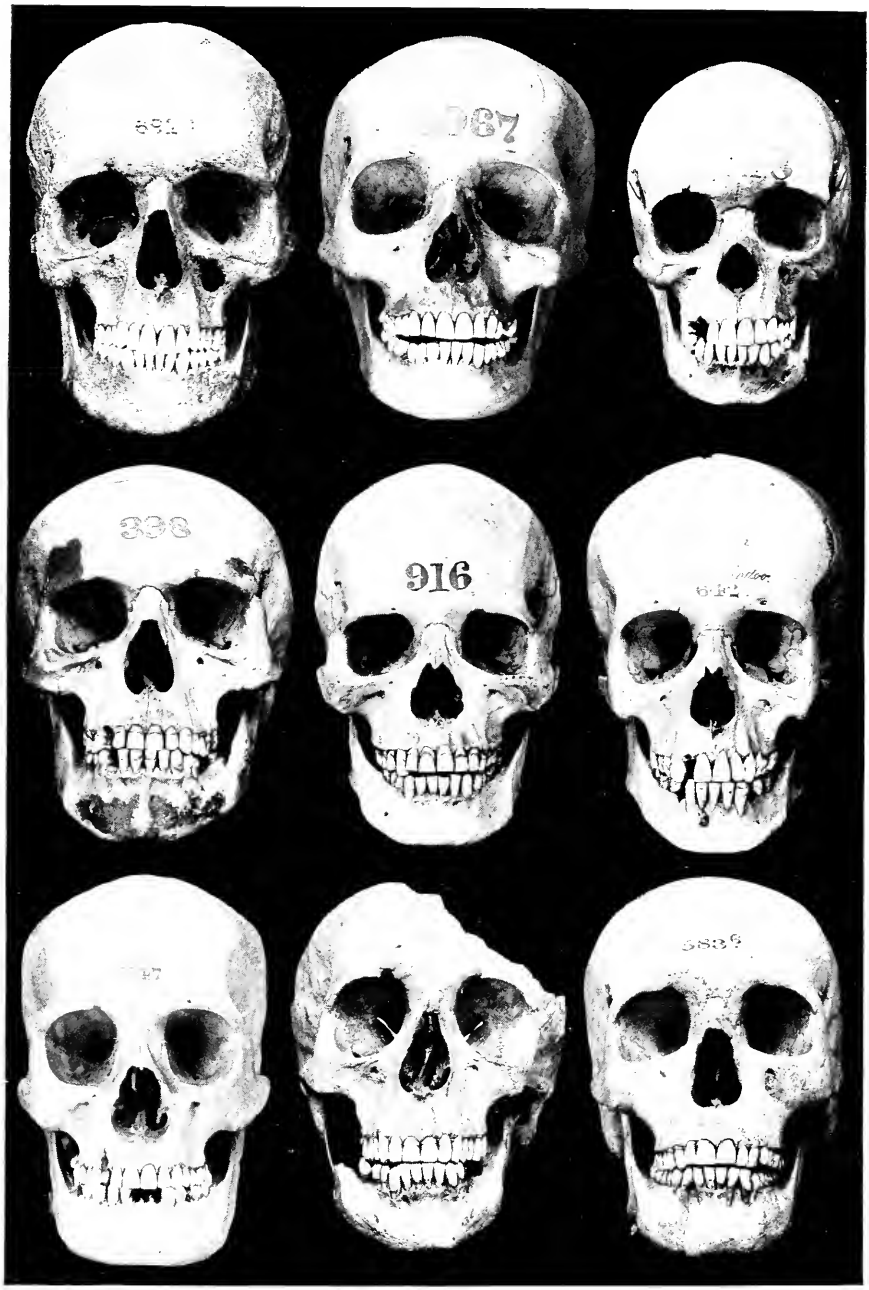


Illustration No. 14

Nine skulls of different races and unlike size and contour, all with teeth of Class I. The form and size of the teeth bear no relation to the form or size of the skull.

Nationalities from left to right are:

Spanish, Sandwich Islanders, New Hebridean, German, Javanese, Hindoo, Fiji Islander, Italian, Ancient Egyptian.

That as a working theory it has always been so vague in statement and indeterminate in application that it has never taken any serious hold upon dentists and is practically a dead letter with more than nine-tenths of the profession; that to teach a theory which no one really practices or understands is immoral, because it leads directly to a disbelief in any scientific basis for prosthetic dentistry; that if there had ever been any real desire to undertake a practical application of the theory it would not have been possible to do so because no manufacturer of artificial teeth has ever made any successful attempt to comply with the demands of the theory; and lastly, that **the theory has absolutely no foundation in scientific fact, because it is fully and incontrovertibly demonstrated that any given forms of teeth are not peculiar to any race,** neither do they bear any necessary relation to the shapes or sizes of skulls. **In all races there is community of typal tooth form.** Small variations in size and small variations in proportion of width to length there certainly are in the teeth of different races, but the three types or classes are present and distinct in all the races I have examined. In fact, one of the most interesting things to me in the course of this investigation has been to see how the three types everywhere persist through the small variations observable in the teeth of different races.[9]

Although just a little aside from our main subject, I think it will interest you to have a glance at a few prehistoric skulls (Illustration No. 16). The three now shown, reading from your left to your right, are known to anthropologists as the man of La-Chapelle-aux-Saints, a typical skull of the very ancient Neanderthal race, the Coombe Capelle man, representing the Aurignacian race, and the "old man of Cro-Magnon," a representative of the race of the same name. Their estimated ages range from 25,000 to 150,000 years. I believe no prehistoric skull has been discovered with an over bite of the upper incisors. The two shown on the right, you see, have the edge-to-edge bite. The third one, the man of La-Chapelle-aux-Saints, must have been a very astonishing and savage looking creature with a very projecting muzzle, huge, flat nose, enormous eye sockets and heavy supra-orbital ridges. Observe that his teeth were nearly all lost from loosening and decay. This skull is also from the Cro-Magnon race. Notice the great depth of the lower jaw and the size of the central incisors, which are fine

[9]Keane, in his table of Ethnology, describes the teeth of the negro races as large (macrodont), those of the Mongols and native Americans as medium (mesodont) and the Caucasian teeth as small (microdont). But the teeth of the mixed races range through all these sizes.

specimens of Class I. I have another skull of the same race in which the teeth are of a totally different type—approaching Class III—with rather small and very beautifully modeled teeth.

The next slide and the following one* show a peculiarity or a specialization of the teeth of the Neanderthal race, which enables us to recognize this ancient people whenever teeth of this type are discovered. This peculiarity is twofold—fusion of the roots and enormous size of pulp cavity.

This photograph shows the efforts of three different artists, all trained anthropologists, to represent different types of prehistoric races.

Let me now call your attention to another discovery I have made, in relation to what has already been shown, that is not only interesting to us as dentists, but has also proved to be of deep interest to anthropologists and workers in other scientific fields. The significance of this discovery is that it traces the origin of these three types of teeth back to a time antecedent to the advent of humanity. When I had made thorough examination of the teeth of the lowest and most primitive races, finding everywhere the three distinct forms, it occurred to me one day that the teeth of the anthropoid apes might throw some light on this question of origin of types. You now have on the screen a photograph (Illustration No. 16) of three skulls of the orang-outang. I have selected these as representing the group of anthropoid apes because the teeth in these three skulls were the most unworn and perfect available at the moment, but the facts are the same with reference to the gorilla (Illustration No. 17) and the chimpanzee (Illustration No. 18).

You will observe that we have here the three types of teeth that we have seen in all the races shown, but, as you would expect, the characteristics of each are rather more strongly marked than in the genus *Homo*. You have the central incisor with parallel sides, the representative of Class I, the incisor with sharply converging sides of Class II, and the one with the fine double curve on its distal side and the generally rounded form which is the special feature of Class III. If there is any temperamental significance in these forms of teeth in the anthropoid apes, I should be glad to have it pointed out.

Another very significant fact in this connection is that in the anthropoid apes the variation in the proportion of width to length of the central incisors in Class I is very marked, some being very short and others very long, while in the other two classes this variation is very slight. Exactly the same thing is true of human teeth.

*These illustrations are not available for use at the time this book goes to press.

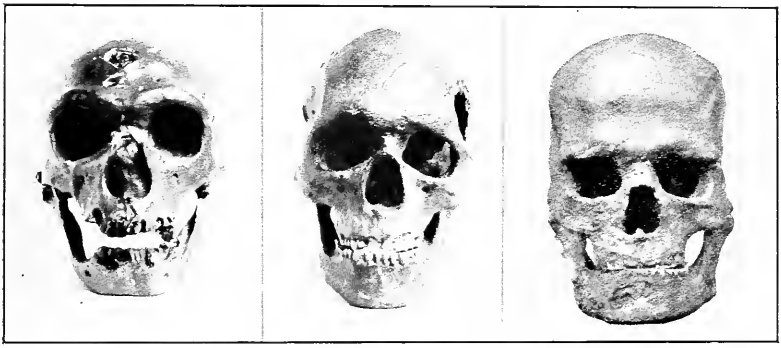


Illustration No. 15. Prehistoric skulls. Neander that at the left

It is for this reason that Class I, in our system, has a series of three lengths with five sizes to each length, while the forms in the other two classes are produced in series of sizes only, or with but slight variation in proportion of width to length.

Whatever the ancestral form may be from which man and the anthropoid apes have descended, or ascended, it is plain that we have here one of the most striking homologies that has been discovered. It is an especially interesting evidence of relationship because it is one of Owen's classical examples of homology and analogy.[10]

The teeth are still functional in both man and the apes. It is clear, therefore, that the origin of the three types of human teeth can be traced back into what the old-fashioned orator was fond of referring to as "the dim mists of antiquity." We have reached something fundamental here that is of very great importance in our work. **Man has three types of teeth because they have been bequeathed to him from his simian ancestors,** just as he has five fingers and five toes, because they have been passed on to him from the early amphibians. You now understand why I call the three severe types or classes of human teeth the "primitive" forms.

It may interest you to know that **this discovery of the fundamental types of teeth in man and the anthropoid apes as shown in these photographs, has been submitted to quite a number of the foremost scientific men of the United States and Europe,** among whom I may mention Prof. Henry Fairfield Osborn, President of the American Museum of Natural History, Professor Schafer of Edinburgh, President of the British Association of Science for 1912; Professor Keith, Hunterian Lecturer at the Royal College of Surgeons, and author of "Types of Ancient Man"; Dr. Woodward, of the Natural History Museum, South Kensington; Dr. A. Russell Wallace, co-discoverer with Darwin of the principle of Natural Selection, and Prof. Ernst Haeckel, of the University of Jena, admittedly the greatest authority who has ever lived in matters of comparative morphology in man and the lower animals. It was of Professor Haeckel's great work on morphology that Huxley said: "It is one of the greatest productions in the history of science." And Darwin said that if he had read Haeckel's "Comparative Morphology" before he began the "Descent of Man," that book would never have been written.

[10] "The wing of a bird and the wing of a bat; they are both fore-limbs of similar structure and development; they are both organs of true flight; they are at once homologous and analogous."—Owen.

"When two or more structures, organs or specialized parts, in one and the same organism, or in several organisms, show a deep resemblance in their architecture and also in their manner of development, they are said to be homologous. . . . Now, the evolutionary suggestiveness of homologies is indisputable."—Evolution, by Thomson and Geddes.

Very interesting comments have been made and no word of criticism has been passed on what seems to be the inevitable conclusion of the facts shown in my photographs. But as the discovery was in the field of comparative morphology it was Professor Haeckel's opinion that I particularly desired.

I think the letter conveying that opinion to me is sufficiently characteristic and interesting to warrant publication.

He says:

Jena, 6, 1, 1913.

Dr. Leon Williams,

London.

Dear Sir.—Your observations on the three different types of the upper central incisors are very interesting, and mainly the fact that the same three characteristic types occur also in the orang-outang and in other anthropoid apes. In my opinion this fact is another new and convincing proof for the near relationship between man and the anthropoid apes, and for the phylogenetic theories that both have been derived from one and the same common ancestor. First, the fact that these three types—in physiological relationship of little value—are so distinctly developed in three morphological directions, seems to me an important proof that the way of phylogenetic divergence of characters is the same in man and in the anthropoid apes.

Very respectfully yours,

(Signed) Ernst Haekel.

With what admirable clearness and conciseness Professor Haeckel's masterful mind has gone straight to the mark in that letter. Three forms or types of teeth have no special physiological significance, as he says. One type is as good as another for purposes of mastication. **But the morphological meaning conveys the story of man's origin, and so becomes one of the most fundamental facts about human teeth.** And on that fundamental fact is established the new classification.[11]

I have several times intimated during the course of this paper that the makers of artificial teeth have never had any scientific guiding principle either for classification or design. Let me finish with that subject now, and I will then take up the constructive part of my work. What have the manufacturers done when they have wished to produce a new pattern of their so-called natural form teeth? They

[11] "In connection with the skull, I may speak of the teeth-organs which have a peculiar classificatory value, and whose resemblances and differences of number, form and succession, taken as a whole, are usually regarded as *more trustworthy indicators of affinity* than any others." Man's Place in Nature, Huxley. The italics are mine.

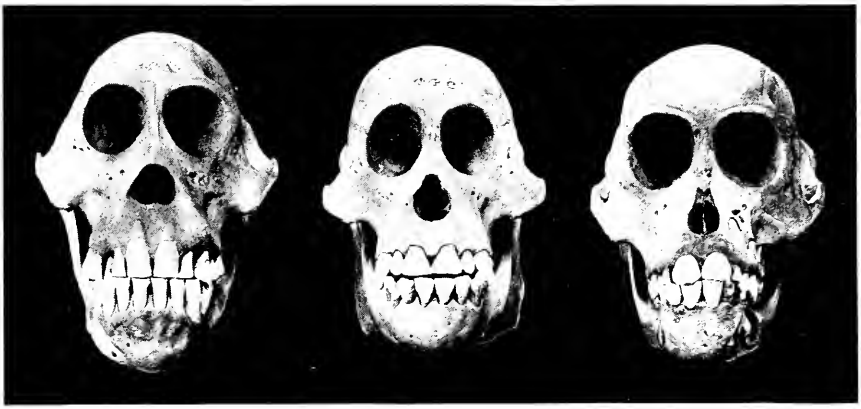


Illustration No. 16. Skulls of orang-outang, showing three primary tooth forms

Illustration No. 17. Three types in skulls of gorilla

Illustration No. 18. Chimpanzee Skulls

have looked about until they found what they considered a particularly attractive looking set of teeth, either in a skull or in the mouth of some living person, and have then copied this set of teeth as well as they could. Well, that work is a long step in advance of the old products of the tooth factories. But for whom are those teeth suitable in artificial dentures? On the assumption that in Nature a set of teeth is in perfect harmony with the face and features, that particular set of teeth could not possibly be in perfect harmony with a different face. But I have called your attention to the fact that should always have been obvious to us, viz., that in Nature there is rarely more than approximations to harmony and often such a lack of harmony that the grotesque is suggested.[12]

If the set of teeth copied was not in harmony with the skull or the face in which they were found, what suggestion has ever been made for their harmonious use? When the manufacturer wishes to produce another mould he finds another set of teeth, and for a third mould a third set of teeth, and so on, ad infinitum. As the minute variations in natural teeth are probably only limited by the number of people dead and living and to be born, is there any good reason why the manufacturers should not go on to the end of time producing new moulds of teeth? And have they not always acted on that principle? **Have not all the companies in existence been turning out new moulds of teeth steadily for nearly a century?** Working according to their present plan, is there any reason why they should ever stop? What is the relation between the teeth of one manufacturer and another? There is none except when they copy each other's patterns, which they frequently do. Nor is there any ordered relation between the teeth of any one manufacturer. **The end of all this is a chaos of confusion doubly confounded,** a vast heterogeneous mass of artificial teeth in which no real artistic principle has been embodied. The present method, even at its highest and best, that is to say, when natural teeth are copied as closely as possible, is an artistic failure, because a work of art cannot be produced by baldly copying Nature.

Let me repeat here and emphasize what I have said in a former paper on this subject, that while all art work must be founded on the most intimate, penetrating and thorough study of Nature that it may be true to life, yet truth to life means much more than an indiscrimi-

[12]In the so-called Natural-form teeth on the market I have noticed that certain natural defects have been copied which make a perfect anatomical occlusion impossible.

nate consideration and acceptance of a mere welter of facts. It means the appreciation and understanding of the relative value of facts, and the power or faculty of discriminating between what is of small value and what is important, characteristic, relevant, fine, all that is really vital to the subject. And that statement fairly introduces the whole problem in the constructive part of our work, which we now approach. The heart of that problem is such a thorough mastery of all the facts of Nature as will enable us to know what it is that gives character in our work and what detracts from it; what makes it beautiful or what causes it to look ugly or commonplace.

Out of the vast confusion and imperfection of Nature we have to isolate, so far as we can, the pure elements of truth and beauty in tooth form, and impress those elements into our service in the work of designing a system of artificial teeth. We have to attempt what every artist undertakes when he seeks to give expression to a more or less ideal conception he has formed after long study and communion with Nature.

When that little group of French artists known as "The Barbizon School" were living together on the borders of the forest of Fontainebleu, someone asked Millais one day which tree he thought the most beautiful, from the artistic point of view. After a few moments' consideration, he replied: **"The one that is in harmony with its surroundings."** A fundamental principle in art was never more finely stated. Exactly the same language may be used to express the relationship between tooth form and face. That tooth is most beautiful for any face which is in most perfect harmony with it. Very well, then we have to determine, if we can, just what it is that constitutes this harmony. Is it entirely a matter of taste and individual judgment, or is there a principle involved which may be demonstrated so that all may see and benefit by it?

Here, as always, we must go to Nature, not to copy baldly everything that we find, but to discover the essential thing. Everyone who has had any experience in this field knows that **if he were to place a set of oval teeth in the mouth of a person who had a very square face, or a set of long teeth in a very short face, the disharmony or falseness would be glaringly evident.** Even the novice in dentistry would almost instinctively select a square tooth for a square face, and a short tooth for a short face. But why are the straight lines of a square tooth in harmony with a square face, and the curved lines of an oval tooth in harmony with an oval face? If we can dem-

onstrate the application of a principle in an obvious case, then we may also be able to apply it when the conditions are somewhat more complex or obscure. I can hardly repeat too frequently that the whole problem is purely an art problem, because that very important fact has never been sufficiently recognized. Now, in all works of art, whether of drawing, painting, sculpture or architecture, harmony or balance is secured in two ways, or by the application of two rules—by parallelism and by opposition of line and curve, and usually by the combination of the two. Excluding color for the moment, *that is the most fundamental thing in all art work.* The severe, classic beauty of a Greek temple is secured almost wholly by the parallel lines of the columns, which are not quite parallel or quite straight. And those upward shooting lines also constitute the chief element of beauty in the more ornate Gothic cathedral of later times. The beauty of the Apollo Belvedere or the Venus de Milo is entirely founded on the balance or opposition of curved lines, and a painting by Turner or Claude or any other great master owes its artistic merits, so far as composition is involved, entirely to the balance of both straight and curved lines.

The principal laws of harmony in all art work involving outline may be briefly stated as follows: Lines that are parallel or nearly so are harmonious; lines that converge or diverge must have other lines, shorter or less in number, set in opposition to them to produce harmony. Curved lines running in a similar direction are harmonious, but branching or diverging curved lines also require opposition lines to complete their harmony.

Those laws or rules are just as applicable to the designing and use of artificial teeth as to building a temple or carving a statue. They are the only rules by means of which a high degree of success may be reached in the adaptation of tooth form to facial contour, and their application is perfectly simple and free from ambiguity, as we shall see presently.

During all the time that I was laying before you proofs of the fallacy of the theory of temperamental tooth form, of the theory of racial tooth forms, of the idea that Nature always produces harmonious tooth forms, and the notion that the way to produce a system, or rather, the absence of a system, in the making of artificial teeth is to copy natural sets of teeth—while I was presenting all of those proofs, I was, at the same time, by use of the facts those proofs contain, building up a system of classification founded not on imaginary dis-

tinctions but on scientific realities. The facts that disprove the temperamental theory are the facts on which the new classification is based.

We are now in a position to gather up the somewhat scattered threads of our proofs and arguments and to show their true significance in the real work of designing a new system of artificial teeth. As a solid basis for that, we have established a new classification for natural teeth in the three primitive forms shown and the secondary and other forms produced by the crossing of these primary forms.

In those three primary forms of teeth we have all the elements of design necessary for producing an indefinite number of varieties of artificial teeth. But an indefinite number are not required. On the contrary, we require comparatively few forms, for the reason that there are but few types of human faces.

Referring, as I understood, to this subject, one of the eminent gentlemen who discussed the paper which I read here in December, expressed the opinion that perhaps the last word in artificial teeth had not yet been said. Well, heaven forfend that the last word on any subject be said by us. That would leave our successors in the unenviable position of having nothing to say.

But let us examine, a little, that expression "the last word" with reference to certain phases of the Trubyte System of teeth. What is the distinguishing feature of this new system? The forms of the teeth and the fundamental, scientific principles on which they have been worked out? While the "last word" can never be said on any subject, yet you have all heard of ultimate facts in nature. These ultimate facts, once discovered, remain ultimate facts forever. More may be learned about the far reaching significance of these facts, but nothing can ever be learned which will upset them or in any way change their essential meaning.

The law of gravitation is an ultimate fact of nature. The turning of the earth on its axis is another. We may go on forever learning more about these great truths, but no further discovery will ever change the essential fact. Now in *form* in nature there are certain ultimate facts. The square is one, the equilateral triangle is another and the circle is a third. You can never get anything more square than an area bounded by four equal sides, the four corners of which are right angles.

You can never get anything more round than an area described by a line every point of which is equidistant from a fixed center. These

are ultimate facts. **So this discovery which I have made of three primary forms of teeth is one of those ultimate facts of nature.** That form of central incisor which approaches most closely to the square must always stand as the typal tooth in that class, and that form which has the straightest and most converging lines and a section of which consequently most closely approximates an equilateral triangle must, necessarily, always stand as the typal form in Class II. Likewise that tooth in Class III, which embodies most of the elements of the circle will always be the representative typal tooth in that class. I submit that there is no getting away from the logic of that proposition.

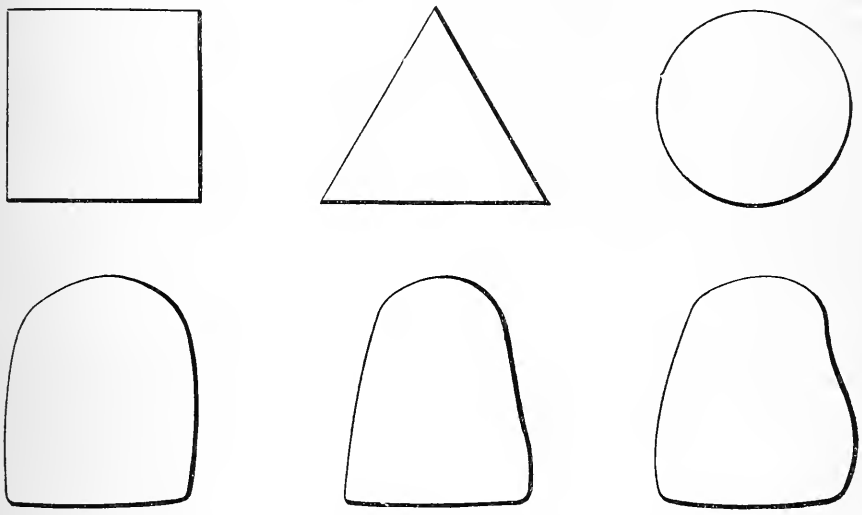


Illustration No. 19
The three simple forms from which all other forms are made

If anyone can find a squarer tooth or a more pyramidal-shaped tooth or a tooth with more marked curves in its proximal lines than those I have exhibited as specimens of the three classes, he will not injure my discovery or the classification founded on it. *On the contrary,* he will further confirm and make it more positive. So far, then, as the classification of human teeth *is* concerned, this *is* the last word in the sense that it is a statement of ultimate facts, and the designing of artificial teeth for all future time must be based on those ultimate facts. When the mind has once grasped an essential truth it can never let go of it. Other manufacturers may bring out teeth shaped like those in the Trubyte System without attempting to classify them, but just to the extent that they are not classified they will be

inconvenient for the dealer to handle and the dentist to select and order. **To produce artificial teeth on any other than the three-form basis is to present the play of Hamlet with Hamlet left out.**

In the elements of design we have in the three primary types of natural teeth, we see what a perfect means we have for producing artificial teeth of all forms necessary for the most complete harmonious relations with every type of human face. When we come to analyze these elements of design, we find that they are very simple, but, as I have said, capable of an indefinite number of beautiful combinations.

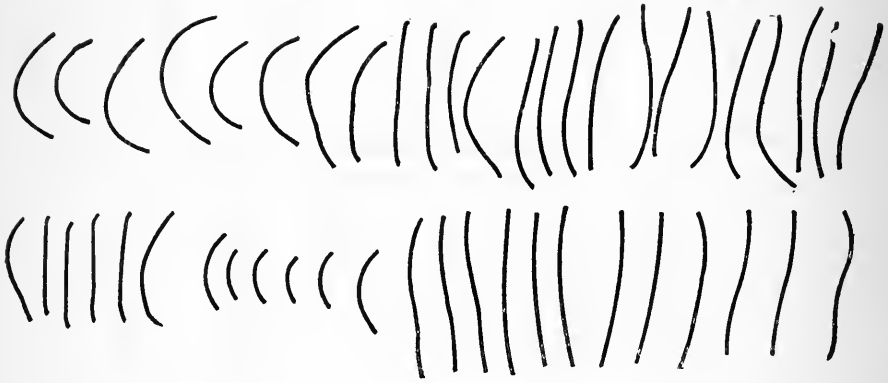


Illustration No. 20
Elements of design, separated

You have on the screen a picture of these elements of design, separated or analyzed as a few curved and straight lines, and combined as one of the typical forms of our classification. Let us see how by slight variations of those few lines we can produce every conceivable form of human tooth—and you will see that we produce our variations after the method of Nature—by crossing the typical forms.

I told you in a former paper that all the fundamental principles of art and design could be applied to the making of artificial teeth. Now what does a competent artist do when he has it in mind to design a fine picture? He decides on the subject and general plan of his painting, and then proceeds to make many careful studies of all the elements which are to appear in the finished work. When it comes to the final composition of the picture, he probably makes several trials before he gets that perfect balance of line and mass that satisfies him.

That is precisely the method that has been employed in designing all these forms of teeth. **The suggestions for most of the designs have come from natural teeth.** The first step has always been to make a number of accurate studies or drawings of the outlines of those natural teeth most closely resembling the intended form. First the centrals, then the laterals and canines, and last, the lower incisors are all laid out so that all can be seen at once and compared. There will be some lines that balance, that are harmonious, and others that are discordant. The problem is precisely that of designing a good com-

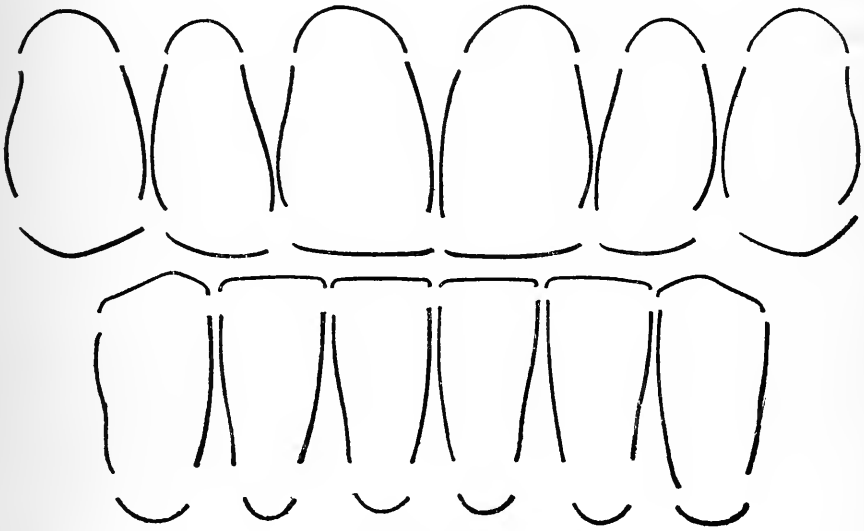


Illustration No. 21
Elements of design, partly assembled

position—to secure perfect harmony of line and mass, and that is not an easy matter in so small an object as a tooth. When it comes to the carving, several are sometimes discarded before the satisfactory result is reached.

All variations in the models of artificial teeth designed for the different types of face are produced by slightly varying the curvature and balance of line of those few simple elements of design in accordance with the contour of face for which the tooth is designed. But the knowledge of how to do that in the best and most artistic manner possible can only be acquired, as all other artistic knowledge is, by much experiment and by long and concentrated study of human teeth and human faces.

The aim, in designing artificial teeth, should always be to maintain character in the tooth by keeping its typal or class features dominant. The most uninteresting and unattractive tooth is one in which the characteristics of all three of the primary types have become so blended that it has no distinction. It is characterless. This whole subject can be illustrated and demonstrated in a few moments by diagrams or outline drawings.

Illustration No. 22 shows perfectly accurate outline drawings of specimens of natural teeth of the three primary classes. You will remember that when I was showing the teeth of the orang-outang I called your attention to the great variation in the proportion of width to length shown in the teeth in Class I. The lower row in the view on the screen illustrates this point again, and I will ask you to keep it in mind when I come to describe the system of constructing porcelain teeth.

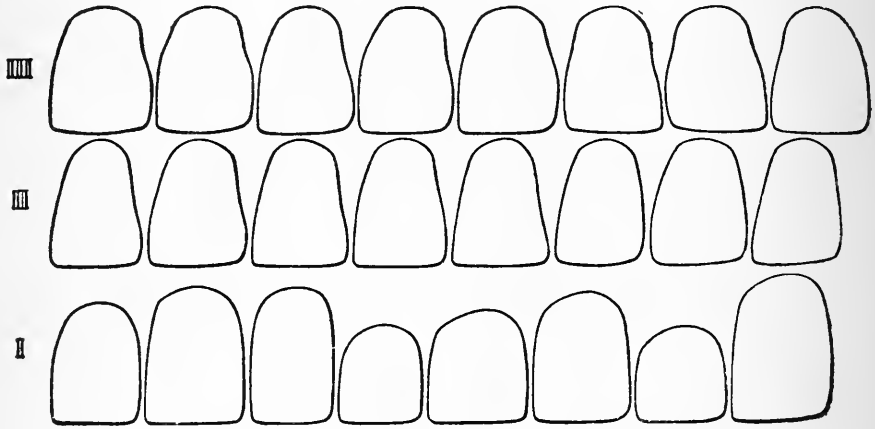


Illustration No. 22. Variations in three primary types

The teeth in the other two rows have all been drawn to the same length, but the proportional width has been preserved. By the crossing of these three types, Nature has produced every form of human tooth that has existed, through all the ages down to the present time. In the very nature of things, some one of those forms or variations will be better adapted to or more harmonious with a given type of face than another. But we have seen that Nature exercises no very fine discrimination in adapting tooth form to facial contour. That means that the vast majority of her variations in teeth are of no particular artistic value. They can be discarded or ignored so far as a system

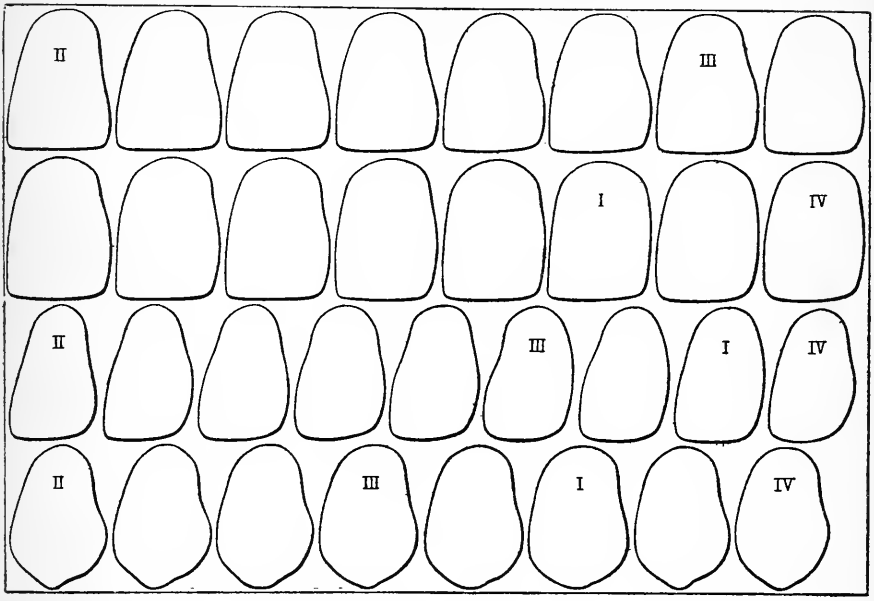


Illustration No. 23

Typal forms numbered. Modifications of those forms by blendings shown beside typal forms.

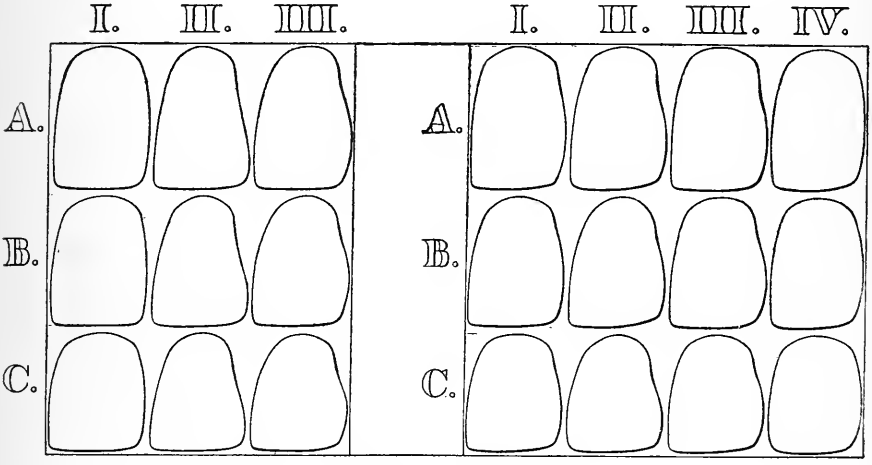


Illustration No. 24

of teeth for edentulous cases is concerned, and the forms that are produced can be far more perfectly adapted to characteristic facial outline than any except the few rare triumphs of Nature.

The facts that I am most desirous of getting clearly before you are that this system is a perfectly natural one, and that all the methods by means of which it has been worked out are no other than such modifications of Nature's own methods of working as will lead us more directly and quickly to our desired end, and in that end give us more uniformly perfect results than are ever found in Nature. In methods and in results it is a perfected artistic compendium of all of Nature's work in teeth.

Our position in this matter of design, in relation to one who produces artificial teeth by simply copying natural ones, may very justly be likened to that of the breeder of animals or the producer of new and improved forms of fruit. We are no longer blind followers of Nature, imitating her defects, but intelligent selectors of principles and utilizers of her secret processes. We eliminate defects. We secure harmony. **The finished results are, in very truth, more natural than any set of natural teeth because harmony is the very first essential of naturalness.** We become the master of Nature instead of being her servant. We utilize everything that is vital and significant and eliminate all that detracts from perfection. Our one aim in all our work is the establishment of harmony between outline or form of tooth and outline of face. And we achieve that by the proper balance and curve of line in the tooth, in relation to the type of face for which it is designed.

If I state the problem in another way you will see at once that it is so. If the size and contour of a tooth is exactly right for a given face, then the harmony is perfect. But the "contour" of a tooth is only another name for the balance of line and curve in the tooth. If the lines and curves of the tooth balance or are in harmony with the lines and curves of the face, then the highest degree of perfection attainable has been reached. And we shall see that there is no difficulty in achieving that perfect result in all edentulous cases. Let us, then, now take up the consideration of the relations of typal tooth forms to

facial contours. And in order to make the application of our new principle perfectly plain, we will begin with the outline diagrams of the four chief types of faces. (Illustration No. 25.)

These outline diagrams show only the strong main lines of the faces, and thus we shall be able to see quickly and clearly the relation of tooth form to these lines.

All of the best writers that I know on the subject of physiognomy are agreed that there are but three well marked classes or types of human faces—the square, the oval and the tapering. **But I think one strong type of face has been overlooked by all writers on the subject.** It is the form which shows a greater width below the eyes than above. The whole lower part of the face is round and rather heavy, and the forehead is usually dome-shaped. I call **this the ovoid face** because it resembles the form of skull to which that name has been given. No form of tooth has ever been made that is well adapted to this shape of face, but those of Class III in our system are perfectly suited to it. These four types of faces have several modifications which we shall consider as we proceed.

In the square face and in its principal modifications, that is to say, in all faces the sides of which are parallel or nearly so, we secure perfect harmony with the teeth of Class I.

If the face is typical or severe in its squareness, then we must use teeth the central incisors of which are parallel on their proximal sides. But the great majority of square faces is not of this type. Usually there is a slight converging of the lines from the forehead to the chin, and the teeth should therefore have lines which converge slightly toward the neck.*

The oval face is the result of a slight rounding of the angles of the square face. Exactly the same modification of the square tooth produces the oval tooth.

Again, in the ovoid face, our tooth outline follows the general contour of the face. The characteristic of this type of face, you will

*In all that we have to say about tooth form, it is always to be understood that we are speaking of the upper central incisors. It is these teeth that are the chief factor in determining harmony with the face, and they also govern the type of all other teeth in the set.

Square face.

Oval face.

Tapering face.

Ovoid face.

Illustration No. 25

remember, is the width, roundness and heaviness of the lower part. This is the special feature of the teeth in Class III. The general character of the tooth of this class and the flow of all its lines correspond perfectly with the ovoid face. In all of the foregoing illustrations harmony is secured by parallelism of tooth outline and face outline.

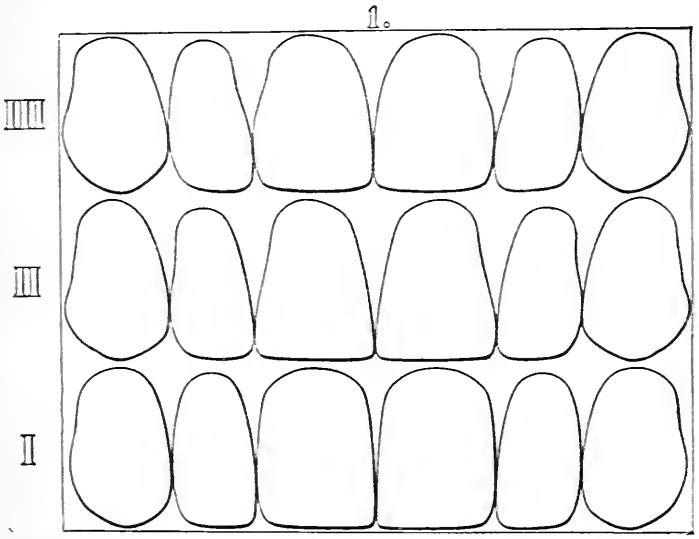


Illustration No. 26. The six upper anteriors in the three primary forms

The tapering face has a wider range of variation than any of the other types. It begins as a slight departure from the square face by the convergence of the cheek lines toward the chin and it presents every gradation of change from this to the extreme convergence seen in the very pointed chin.

In all faces of this character the lines of the proximal surfaces of the upper central incisors run in opposition to the lines of the face. If the lines of the face converge but little toward the chin the proximal lines of the teeth should converge but little toward the neck of the tooth.

The amount of line convergence in the face governs the amount in the teeth. If this line convergence is accompanied by rather full, round cheeks, then the disto-proximal surface of the upper centrals should also be rounded or convex. In selecting teeth for the tapering face of any degree, you have only one principle to keep in mind, so far as tooth form is concerned, and that is that the contour lines of your upper incisors must be, in a general way, the reverse of what

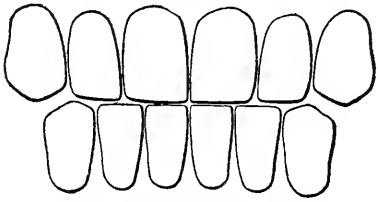
they are in the face. The observance of this rule will always give you perfect harmony—the harmony of opposition of line.

If I have now made clear the fundamental governing principle in the relation of facial contour to tooth form, we will rapidly pass in review a few photographs of the more striking and distinctive types of faces. (Specimens were shown on the screen.)

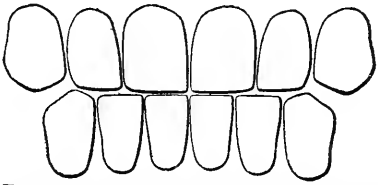
We will first examine the forms of teeth best suited to the square face and its immediate modifications, the shorter and longer face of the same type. I am taking these all together in three groups for a special reason. When we were looking at the teeth of the orang-outang you will remember I told you that teeth of the square type, or those with parallel sides, varied more in proportion of width to length than any others, and I added that as the same fact was observable in faces I had designed a special series of teeth to meet these conditions. This series is known as Forms 1, 2, 3, 4 and 5 in Class I as now shown on the screen (Illustration No. 27). As all of the faces are of the same general type, differing only in proportion of width to length, so the teeth are of one type differing only as the faces do. The teeth are not of the most severe typal form. There is a very slight convergence of the proximal lines and a slight convexity of the disto-proximal surface. The reason for that is that there are but very few faces of the most severe, square, typal form and even for these the forms of teeth shown would be perfectly suitable. But there is a very great number and a wide range of faces showing slight modification of the square type. It is to meet that wide range of face found in nearly all countries that this series of teeth has been designed. There are five sizes to each form, except Form 4, in which the extremely large form is unnecessary. I will ask your close attention for a few moments while I point out to you what it means to have a series of teeth of one model like this. In the first place, there is a very wide range of face in the long, medium and short varieties of the square type for which this series is perfectly suited. But its usefulness and convenience extends much beyond that. You have all had the experience of finding the exact type of tooth you wanted for a given case, but in a larger or smaller size than the case demanded, and you know the feeling it has given you to find that the model tooth you wanted was not made in any other size than the one you could not use. Well, that situation can never occur in the system of teeth now suggested. No form will ever be brought out in one size only. That seems to me to be about the most senseless feature that can be charged to the old regime.

CLASS I MOULDS

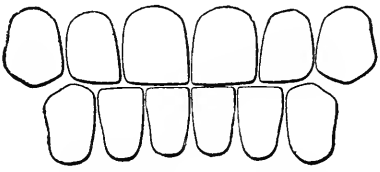
(Illustrations show form but not sizes.)



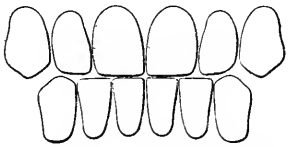
Form 1. The long modification of the square form.
Sizes from small to large from moulds 1C, 1D, 1E, 1F, 1H.



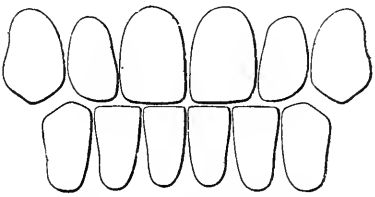
Form 2. The medium long modification of the square form.
Sizes from small to large from moulds 2C, 2D, 2E, 2F, 2H.



Form 3. The short modification of the square form.
Sizes from small to large from moulds 3C, 3D, 3E, 3F, 3H.



Form 4. The feminine modification.
Sizes from small to large from moulds 4C, 4D, 4E, 4F.



Form 5. Oval modification.
Sizes from small to large from moulds 5C, 5D, 5E, 5F, 5H.

Illustration No. 27

Square face—long.
Class I, Form 1.

Square face—long.
Class I, Form 1.

Square face—medium.
Class I, Form 2.

Feminine square.
Class I, Form 4.

Square face—short.
Class I, Form 3.

Oval face, a modification of the square.
Class I, Form 5.

Illustration No. 28

In this particular series we have five sizes in each group, except Form 4, which has four sizes. But there is more than that in it. In all cases for partial plates the absorption following extraction makes it necessary to use a tooth longer than the adjoining natural one, yet you should have a tooth of the same general type. Suppose it is a case in which one central of the short series, No. 3, is missing. The space to be filled demanding a longer tooth of this type, you simply pass from Form 3 to Form 2 and find exactly what you require. If your standing natural central should be of medium length then you pass from 2 to 1 to get what you want. Now, if you will think for a moment what it means to have such a range of selection in a form of tooth for a great variety of the type of face most frequently met, you will, I think, see that this one series of 24 sets is far more valuable for a dentist to keep in stock than twenty times that number of the heterogeneous moulds without system or relation as formerly made, not to mention any of the other very important points of superiority of the new models.

The short tooth of Form 3 is, of course, for the type of short face, shown in Illustration No. 28. Form 2 is for faces of medium length, and Form 1 is for the long faces.

The arch of the teeth in the upper jaw of the short and medium square faces is the segment of a larger circle than would be required for any other type of face. There is but little overlap of the upper incisors in this type of face and when the teeth become worn the bite is nearly square, especially in the short face. In the long face there is usually some overlapping of the centrals or laterals.

Illustration No. 28 shows the first modification of the square face in the direction of the oval. It is, perhaps, more frequently met with in the United States than in any other form. Teeth of Form 2, Class I, are also perfectly suited for the male face of this type, **but for the feminine face I have designed and carved Form 4, Class I.** The greatest possible care was given to the modelling of this group of teeth and they have been designed to produce a perfect harmony with one of the finest types of the feminine face in America and England. Slight overlapping of laterals adds to the beauty and naturalness of appearance. The general appearance of the arch is the same as in the square face, but is a little more rounded at the front. They have a slight rounding of the mesial and distal incisal angles. Slight overlapping of the centrals is nearly always found in the finest specimens of natural teeth of this type.

In the tapering form of face the female type is the most delicate, and by many considered the most artistic form of feminine

beauty. It is a type of face frequently found in Italy. Women with faces of this type were usually selected by the great Italian masters as models for their representations of the Madonna, and it is worthy of note that this is the type of face depicted by the great English portrait painters of the late eighteenth century as that of the famous beauty, Emma, Lady Hamilton. All of the teeth in Class II, except Form 1, have been designed for this form of face. The masculine face of this type, with converging lines, often presents very strong

Tapering face—long.
Class II, Form 1.

Tapering face.
Class II, Form 2.

Tapering face—long.
Class II, Form 3.

Tapering face.
Class II, Form 4.

Illustration No. 29

features. The lines of the cheek, from the malar bones to the lower jaw, although converging considerably towards the chin, are very straight and firm. For this type of face the teeth of Form 1, Class II, have been made. There is no overlapping of the teeth in the strongest type of face of this class.

For the shorter tapering female faces in this class forms have been designed, and also for the medium and longer tapering faces. In all of these types, particularly those with the sharper form of face, with a somewhat pointed arch, there is often more or less overlapping of both centrals and laterals, but especially centrals.

On page 44 are two of the long tapering faces which are, I believe, much more frequently found in England and some parts of Italy than in Germany or the United States, although many of the old New England stock had long faces. The teeth best suited to this type of face will be rather long, with converging proximal lines such as are seen in forms of Class II. We sometimes find in faces of this type, in England, a rather short upper lip. In such cases, and, in fact, in all cases where we find a short upper lip combined with prominence of jaw, I think it better always to use short teeth or those of medium length.

But teeth with tapering proximal sides should be selected for all variations of the tapering face. The duplication and reversal of the lines of the face in the shorter lines of the teeth produces an effect of balance and harmony which a trained artist would perceive and understand in a moment. If the face is long and only slightly tapering, then the teeth of Form 1, Class I will give a good effect. In all tapering faces with rather full cheeks the teeth in Class III are also perfectly suitable. Harmony is produced with these teeth, as with those of Class II, by contrast or reversal of line.

Illustration No. 30 is the type of face to which I have given the name "ovoid," and for which the teeth in Class III have been specially made. The greatest width of the face, as I have already pointed out, is in the region of the malar bones. But the entire lower part of the face is heavier than in any other type. The cheeks are full, round, and thick. Women with these facial characteristics are sometimes spoken of as belonging to the voluptuous type. The beautifully curved outlines and generally rounded character of the teeth in Class III will give the most harmonious and satisfactory effects in faces of this type.

Slight depression of the laterals gives that prominence to the canines which is in keeping with the strongest form of this face. With the more delicate and refined type of face of this class there should be overlapping of the laterals. The arch, as you see, is rounder than in any other type.

Ovoid face.
Class III, Form 1

Ovoid face.
Class III, Form 2

Ovoid face.
Class III, Form 3

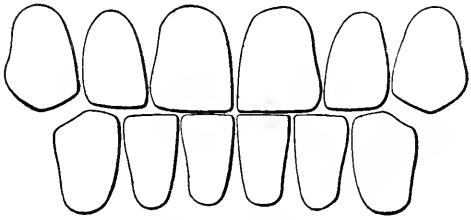
Ovoid Face.
Class III, Form 4

Illustration No. 30

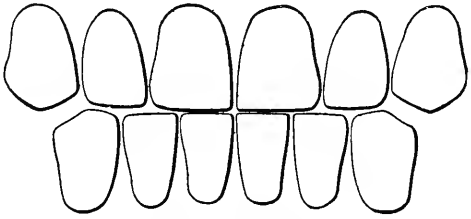
I have shown you how the bolder forms of teeth in the present system are adapted to the typal forms of faces. The general application of the system to modifications of the typal faces can best be

CLASS II MOULDS

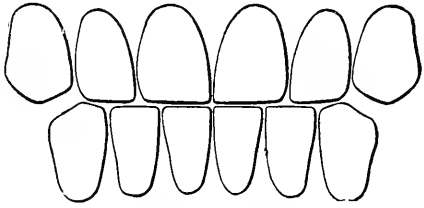
(Illustrations show form but not sizes.)



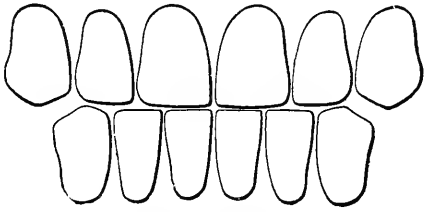
Form 1. Class II.
A severe, nearly typal form.
Sizes from small to large from moulds 1L, 1M, 1N, 1P, 1R.



Form 2. Class II.
Slightly modified by crossing with Class III.
Sizes from small to large from moulds 2L, 2M, 2N, 2P, 2R.



Form 3. Class II.
Slightly modified by crossing with Class I.
Sizes from small to large from moulds 3L, 3M, 3N, 3P, 3R.



Form 4. Class II.
Modified by Class III, a little more than Form 2.
Sizes from small to large from moulds 4L, 4M, 4N, 4P, 4R.

Illustration No. 31

seen by exhibiting the table of classification, (pages 49 to 61), in which will appear the whole system in one view.

This table of classification presents three classes founded on the three primitive types of natural teeth. Each class contains modifications of the primary types corresponding with the variations in the types of faces. The forms **most closely resembling the primitive forms in natural teeth, are most suitable for the strong, characteristic or typal forms of faces.** In nearly all faces which result from the crossing of types we shall find one or other type dominant. Any given face will approximate to the square, the oval, the tapering or the ovoid form. We shall therefore determine the dominant factor and select our teeth accordingly. Each section of the table represents a series of sizes of one form of tooth. The teeth in any one section are called a series, the only difference in all the teeth in a series being that of size. They are all precisely the same form, but in sizes to match variations in size of faces of the same type. This is an entirely new feature in the manufacture of artificial teeth. How often we have had the experience of fixing upon a certain shape of tooth, but which was either too large or too small for our purpose, only to find that no other size of that model was made. That, to my mind, has always been one of the most incomprehensible inconsistencies of the old order of things. **Three or four sizes in each series will meet nine-tenths of the demands.** While on this subject of size of teeth perhaps I had better say that I think the **chief determining factor in adapting size of teeth to face should be size of external mouth, opening and other features** rather than general size of face. Small teeth in a mouth with large opening, no matter what the size of face may be, will always look hideous.

You are beginning to see now the comprehensiveness, the completeness and the simplicity of this scheme of classification. In this series of tables you have an arrangement that banishes all uncertainty and guesswork. A patient comes to you for artificial teeth. You first determine in what class the face belongs. If it is not a pure type you decide on the dominant feature and determine that it is a modification of the square, the oval, or the tapering face. You then select your teeth on precisely the same principle. If it is a square face just pass-

(Continued on page 62.)

CLASSIFICATION TABLE
TRUBYTE TEETH

CLASS I

MODIFICATIONS OF THE SQUARE TYPE

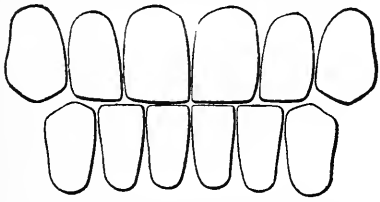
FIVE FORMS IN GRADED SIZES

WHEN DIMENSIONS ARE NOT GIVEN THE SIZES ARE IN PREPARATION.
ALL DIMENSIONS ARE IN MILLIMETERS.

Similar dimensions in plain vulcanite pin teeth; combination sets with individual diatoric posteriors, and combination sets with molar blocks.

FORM 1. THE LONG MODIFICATION OF THE SQUARE TYPE.

Illustration represents form but not sizes.



Form 1. The long modification of the square form.
Sizes from small to large from moulds 1C, 1D, 1E, 1F, 1H.

UPPERS

Mould No.	Length Central Without Collar	Width 6 anteriors Set up	Width Full 14 Set up	Combined Bite and Shut of Central	Width of Central
1C					
1D	9.75	42–43	103.	8.	7.
1E	10.25	45.	108.	9.	7.5
1F	10.75	46–47	109–110	9.5	8.
1H	11.50	51.	123–124	9.5	8.5

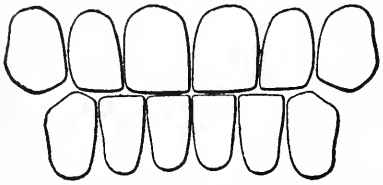
LOWERS

Mould No.	Length Central Without Collar	Width 6 anteriors Set up	Width Full 14 Set up	Combined Bite and Shut of Central	Width Four Incisors
1C					
1D	9.	32.5	102.	9.	21.
1E	9.	36.	104.	9.	22.5
1F	9.5	36.	106.	9.	23.
1H	10.25	40.	115.	9.5	25.

CLASS I.

FORM 2—Medium Long, Square.

Illustration represents form but not sizes.



Form 2. The medium long modification of the square form. Sizes from small to large from moulds 2C, 2D, 2E, 2F, 2H.

UPPERS

Mould No.	Length Central Without Collar	Width 6 anteriors Set up	Width Full 14 Set up	Combined Bite and Shut of Central	Width of Central
2 C	8.50	42-43	102-103	8.	7.
2 D	9.25	44	103	8.5	7.5
2 E	10.	46-47	108-109	9.25	8.
2 F	10.75	48-49	110-111	9.5	8.25
2 H					

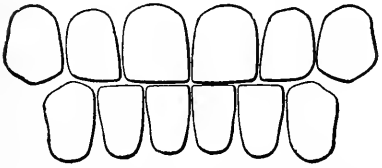
LOWERS

Mould No.	Length Central Without Collar	Width 6 anteriors Set up	Width Full 14 Set up	Combined Bite and Shut of Central	Width Four Incisors
2 C	8.5	33.	100	7.5	20.
2 D	9.	34.	101	9.	21.5
2 E	9.	36.5	106	9.	23.
2 F	10.	37.	106	9.5	23.5
2 H					

CLASS I.

FORM 3—Short Square.

Illustration represents form but not sizes.



Form 3. The short modification of the square form.
Sizes from small to large from moulds 3C, 3D, 3E, 3F, 3H.

UPPERS

Mould No.	Length Central Without Collar	Width 6 anteriors Set up	Width Full 14 Set up	Combined Bite and Shut of Central	Width of Central
3 C	8.	44-45	105-106	8.	7.75
3 D	8.75	45-46	108-109	8.	8.
3 E					

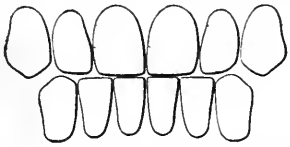
LOWERS

Mould No.	Length Central Without Collar	Width 6 anteriors Set up	Width Full 14 Set up	Combined Bite and Shut of Central	Width Four Incisors
3 C	7.75	35.	103.	8.	23.
3 D	8.75	36.	106.	8.50	23.
3 E					

CLASS I.

FORM 4—The Feminine Modification of The Square Type.

Illustration represents form but not sizes.



Form 4. The feminine modification.
Sizes from small to large from moulds 4C, 4D, 4E, 4F.

UPPERS

Mould No.	Length Central Without Collar	Width 6 anteriors Set up	Width Full 14 Set up	Combined Bite and Shut of Central	Width of Central
4 C					
4 D	9.	40.	97.	8.	7.
4 E					
4 F	10.0	45.	107.	9.	8.

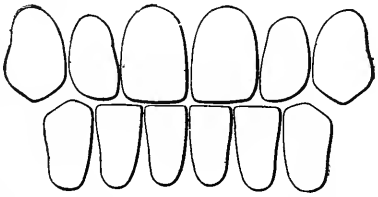
LOWERS

Mould No.	Length Central Without Collar	Width 6 anteriors Set up	Width Full 14 Set up	Combined Bite and Shut of Central	Width Four Incisors
4 C					
4 D	8.	29.	93.	8.	18.
4 E					
4 F	9.	33.	102-103	8.	21.

CLASS I.

FORM 5—The Oval Modification of The Square Type.

Illustration represents form but not sizes.



Form 5. Oval modification.
Sizes from small to large from moulds 5C, 5D, 5E, 5F, 5H.

UPPERS

Mould No.	Length Central Without Collar	Width 6 anteriors Set up	Width Full 14 Set up	Combined Bite and Shut of Central	Width of Central
5 C					
5 D					
5 E					
5 F					
5 H	11.5	50.		9.	8.50

LOWERS

Mould No.	Length Central Without Collar	Width 6 anteriors Set up	Width Full 14 Set up	Combined Bite and Shut of Central	Width Four Incisors
5 C					
5 D					
5 E					
5 F					
5 H	10.5	38.		8.5	23.5

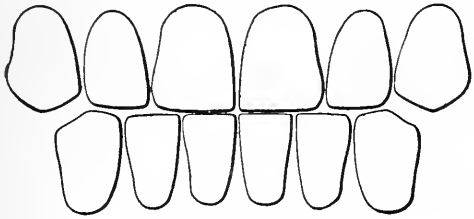
CLASS II.

MODIFICATIONS OF TAPERING TYPE

FOUR FORMS IN GRADED SIZES

FORM 1.—The Severe Modification of The Tapering Type.

Illustration represents form but not sizes.



Form 1. Class II.
A severe, nearly typal form.

Sizes from small to large from moulds 1L, 1M, 1N, 1P, 1R.

UPPERS

Mould No.	Length Central Without Collar	Width 6 anteriors Set up	Width 14 Set up	Combined Bite and Shut of Central	Width of Central
1 L					
1 M					
1 N	10.5	53.	120.	9.5	8.5
1 P	11.	55.	122.	9.5	9.
1 R					

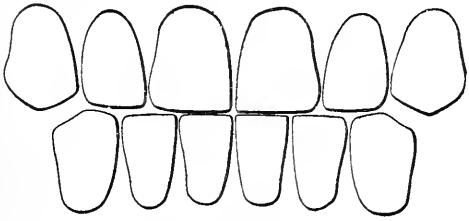
LOWERS

Mould No.	Length Central Without Collar	Width 6 anteriors Set up	Width 14 Set up	Combined Bite and Shut of Central	Width Four Incisors
1 L					
1 M					
1 N	10.	42.	112.	8.5	26.
1 P	10.	44.	114.	10.	27.
1 R					

CLASS II.

FORM 2—Second Modification of The Tapering Type.

Illustration represents form but not sizes.



Form 2. Class II.
Slightly modified by crossing with Class III.

Sizes from small to large from moulds 2L, 2M, 2N, 2P, 2R.

UPPERS

Mould No.	Length Central Without Collar	Width 6 anteriors set up	Width 14 Set up	Combined Bite and Shut of Central	Width of Central
L					
2 M	8.75	41.	103.	8.	7.
2 N	9.75	44.	106.	8.	7.5
2 P	10.50	47-48	111.	9.	8.
R					

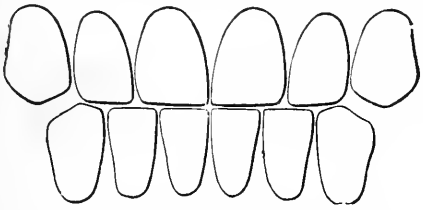
LOWERS

Mould No.	Length Central Without Collar	Width 6 anteriors Set up	Width 14 Set up	Combined Bite and Shut of Central	Width Four Incisors
L					
2 M	8.	33.	99-100	8.	20.
2 N	9.	34.	102.	9.	21-22
2 P	10.	37.	108.	9.5	23-24
R					

CLASS II.

FORM 3—The Third Modification of The Tapering Type.

Illustration represents form but not sizes.



Form 3. Class II.
Slightly modified by crossing with Class I.

Sizes from small to large from moulds 3L, 3M, 3N, 3P, 3R.

UPPERS

Mould No.	Length Central Without Collar	Width 6 anteriors Set up	Width 14 Set up	Combined Bite and Shut of Central	Width of Central
L					
M					
3 N	9.75	45.	105.	8.	8.
3 P	10.50	50.	124.	8.5	8.5
R					

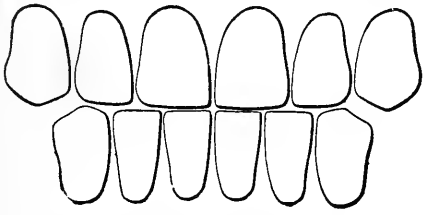
LOWERS

Mould No.	Length Central Without Collar	With 6 anteriors Set up	Width 14 Set Up	Combined Bite and Shut of Central	Width Four Incisors
L					
M					
3 N	9^2	36.	103.	9.	22.
3 P	9^2	38.	114.	8.	25.
R					

CLASS II.

Form 4.—The Fourth and Softest Modification of the Tapering Type.

Illustration represents form but not sizes.



Form 4. Class II.
Modified by Class III, a little more than Form 2.
Sizes from small to large from moulds 4L, 4M, 4N, 4P, 4R.

UPPERS

Mould No.	Length Central Without Collar	Width 6 anteriors Set up	Width 14 Set up	Combined Bite and Shut of Central	Width of Central
4 L					
4 M	8.75	41.	98-99	9.	8.
4 N	9.75	44-45	106.		
4 P					
4 R					

LOWERS

Mould No.	Length Central Without Collar	Width 6 anteriors Set up	Width 14 Set up	Combined Bite and Shut of Central	Width Four Incisors
4 L					
4 M	9.	31.5	95.	9.5	19.5
4 N	9.	35.	103.	9.5	22.
4 P					
4 R					

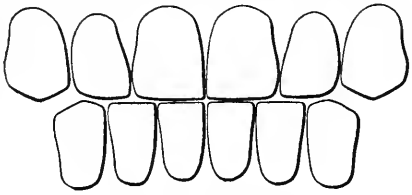
CLASS III.

MODIFICATIONS OF THE OVOID TYPE

FOUR FORMS IN GRADED SIZES

FORM 1—The Severe Modification of The Ovoid Type.

Illustration represents form but not sizes.



Form 1. Class III.
Sizes from small to large from moulds 1T, 1U, 1W, 1X, 1Y.

UPPERS

Mould No.	Length Central Without Collar	Width 6 anteriors Set up	Width Full 14 Set up	Combined Bite and Shut of Central	Width of Central
1 T					
1 U					
1 W					
1 X					
1 Y					

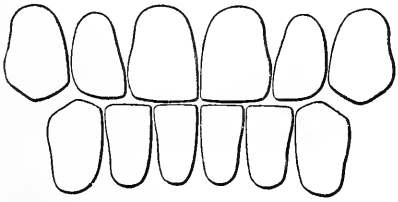
LOWERS

Mould No.	Length Central Without Collar	Width 6 anteriors Set up	Width Full 14 Set up	Combined Bite and Shut of Central	Width Four Incisors
1 T					
1 U					
1 W					
1 X					
1 Y					

CLASS III.

FORM 2—The Second Modification of The Ovoid Type.

Illustration represents form but not sizes.



Form 2. Class III.
Sizes from small to large from moulds 2T, 2U, 2W, 2X, 2Y.

UPPERS

Mould No.	Length Central Without Collar	Width 6 anteriors Set up	Width 14 Set up	Combined Bite and Shut of Central	Width of Central
2 T					
2 U					
2 W					
2 X					
2 Y					

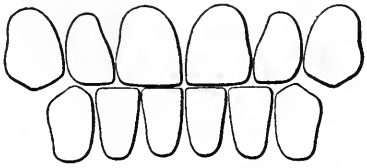
LOWERS

Mould No.	Length Central Without Collar	Width 6 anteriors Set up	Width 14 Set up	Combined Bite and Shut of Central	Width Four Incisors
2 T					
2 U					
2 W					
2 X					
2 Y					

CLASS III.

FORM 3—The Third Modification of The Ovoid Type.

Illustration represents form but not sizes.



Form 3. Class III.
Sizes from small to large from moulds 3T, 3U, 3W, 3X, 3Y.

UPPERS

Mould No.	Length Central Without Collar	Width 6 anteriors Set up	Width 14 Set up	Combined Bite and Shut of Central	Width of Central
3 T					
3 U					
3 W					
3 X					
3 Y					

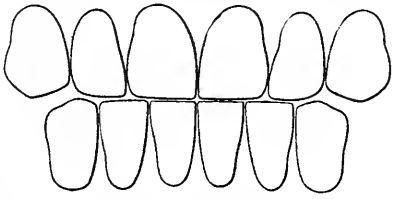
LOWERS

Mould No.	Length Central Without Collar	Width 6 anteriors Set up	Width 14 Set up	Combined Bite and Shut of Central	Width Four Incisors
3 T					
3 U					
3 W					
3 X					
3 Y					

CLASS III.

FORM 4—The Softest Modification of The Ovoid Type.

Illustration represents form but not sizes.



Form 4. Class III.
Sizes from small to large from moulds 4T, 4U, 4W, 4X, 4Y.

UPPERS

Mould No.	Length Central Without Collar	Width 6 anteriors Set up	Width 14 Set up	Combined Bite and Shut of Central	Width of Central
4 T					
4 U					
4 W					
4 X					
4 Y					

LOWERS

Mould No.	Length Central Without Collar	Width 6 anteriors Set up	Width 14 Set up	Combined Bite and Shut of Central	Width Four Incisors
4 T					
4 U					
4 W					
4 X					
4 Y					

ing into the tapering form, you select a tooth with slightly converging proximal lines and your harmony is perfect. Each set of teeth in a series is numbered and the length and width of the centrals and combined width of the six upper fronts is given on one line opposite the number. You therefore have under your eye every condition for giving you exactly what you want. All the old wearisome, vexing search among the miscellaneous collections of the trays is ended. You work quickly, positively, accurately, artistically, as scientific men should.

All of the teeth in Class III are in an entirely new field, as models of this beautiful type have never been made by any manufacturer before. And so far as my knowledge goes, only one model in Class II has ever before been produced. By classifying and systematizing the work I have therefore given you a far wider range of tooth-form than you have ever had before, and with comparatively few forms.

And thus, you see, for the old vague, complex and bewildering effort at instruction in the adaptation of teeth to certain hypothetical temperamental conditions, which nobody ever understood because they never existed, we substitute a few simple, clear, positive rules, based on a fundamental esthetic principle. And the essence of that principle is the direct adaptation of tooth form to facial contour. **A square tooth for a square face; an oval tooth for an oval face; an ovoid tooth for an ovoid face, and teeth with proximal lines converging toward the neck for the tapering faces with lines converging toward the chin.**

While the improvements in the outline forms and proportions of which I have been speaking are fundamental improvements in the new forms of teeth, because they strike at the very foundation of good prosthesis, it has been possible to incorporate into the anteriors of the new teeth other improvements, some of which have long been asked for by the dental profession. I shall refer to these under the headings of:—

IMPROVED LABIAL SURFACES AND IMPROVED COLORINGS.

Many a dentist who has had difficulty in making a satisfactory restoration of a lost natural tooth, even when the artificial tooth has

seemed of the right size, form and color, has been at a loss to account for the difficulty, and has attributed it to the difference in appearance between the natural tooth and the porcelain.

The fact has been that the porcelain tooth reflected the light in a different way than the natural tooth did, because the natural tooth presented a slightly roughened labial surface which diffused the light, while the porcelain tooth presented a smooth surface which did not diffuse it. (It should be noted here that some natural teeth have smooth labial surfaces, but they seem to be in the minority, and are not as pleasing in color as those with rougher surfaces.)

If the labial surface of an upper central which is beautiful in color and softness **be carefully examined, it will be seen to present very delicate longitudinal striations** due to the succession of calcification of the ameloblasts or enamel cells. These striations have a very constant pattern which is horizontally across the labial surface of the tooth, by a series of compound curves. The striations undergo regular changes in form and size in different parts of the tooth.

These striations work very important color effects in the appearance of the teeth. They soften the high lights which would otherwise be reflected with much brilliancy from certain parts of the tooth, and which would often make the teeth a point of too strong light to harmonize well with the rest of the face. They soften the shadows, which would otherwise be too deep. They do this by breaking up the waves of reflected light so that they are not returned to the eye in that rhythmical succession given by polished surfaces. The result is that the whole surface of the tooth is rendered considerably softer than it would otherwise be.

Not only is this surface of the tooth rendered softer, but careful experiments with optical instruments seem to show that the whole outline of the tooth is given a softer appearance by this diffusion of light.

The methods in use for the commercial production of porcelain teeth have not permitted the reproduction of labial surfaces which could diffuse the reflected light in the manner just referred to. We have had strong developmental grooves and occasional cross grooves, possibly intended to represent deficient calcification. Otherwise the labial surfaces have been smooth.

The result of the smoothness of porcelain labial surfaces has been *that* the light from them has not been diffused and softened. The high lights have been strong and the shadows deep. The outlines have been always clearly defined. And when placed beside natural teeth of even like form and color, they have presented, to the observing eyes, differences which have often made them unsatisfactory. The general comment was that the teeth looked "too glassy."

This matter of diffusing the reflected lights and giving Trubyte teeth more natural appearances has received the most exacting attention, with the result that the **labial surfaces of Trubyte teeth present enamel markings which are anatomically correct in form and which soften the reflected high lights and shadows in the same way the natural teeth do.**

This softening of the lights and shadows changes the whole appearance of the teeth, so that they seem to be of a different porcelain or texture from similar teeth not so softened.

This improvement, which I have passed over in few words, is of the very greatest value to the prosthetic worker who wishes to render his patient a high type of service and receive a proper fee therefor. When these moulds are produced in facings and crowns, the full force of the improvement will be apparent to all.

The incorporation of these enamel markings, in correct form, has been a task of great difficulty. It has been necessary to perfect a new and improved method of mould making, and this has demanded almost two years of constant labor.

COLOR IN ARTIFICIAL TEETH.

If the knowledge of form in natural and artificial teeth has been in a chaotic condition there has hardly been sufficient scientific knowl-

edge of color in teeth to justify the use of the word "chaotic" or any other adjective concerning it. **We have known practically nothing and certainly nothing practical about the right use of color in porcelain teeth.**

As time went on and I became more and more absorbed in the study and investigation of tooth form and in the practical working out of the results of my investigation in carving models for the Trubyte System, it became apparent that some one else would have to take up this matter of analyzing the color of different types of natural teeth and adapting the results obtained in this branch of our work to the new system of artificial teeth.

Dr. Clapp kindly offered to take this work off my hands, and he entered upon this very difficult task with the earnestness and determination that he puts into everything that he undertakes.

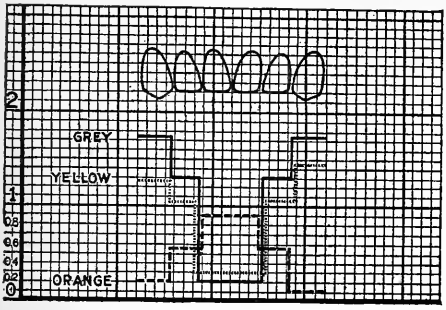
This work, under his direction, has now been in progress for nearly two years, and the first results are being embodied in the Trubyte system of teeth.

Many progressive dentists here in America and others in Europe had, for years, been calling attention to the unnatural coloration of artificial teeth, **but no one had ever suggested any standard of color and no one had ever determined what the actual colors are in human teeth.** This, then, was the arduous task Dr. Clapp took upon himself. He had first to determine the actual primary and secondary colors in natural teeth, and he had then to discover or invent a method of standardizing the results of this investigation so as to secure a practical application of the knowledge gained to the coloration of artificial teeth.

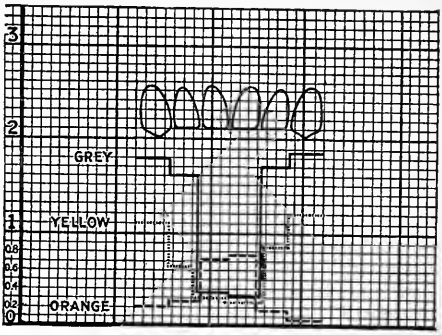
He was fortunate at the outset in being able to secure the services of one of the world's greatest commercial color experts. With his aid, the colors in a large number of sets of natural teeth were carefully analyzed and recorded in exact terms. The secondary and tertiary colors were worked out, and the whole thing reduced to charts, and finally to paintings representing the exact depth of color in different teeth and the distribution of that color.

COLOR ANALYSIS

Miss D. A.	Age 19 Ht. 5.6″ Wt. 119 lbs.	Red	Yellow	Blue	Color Developed		
					Black	Orange	
	Eyes	17.5	43.0	16.0	16.0	1.5	25.5 yel.
	Hair	Dead	Black				
	Skin	4.1	3.0	.88	.88	2.12	1.1 red
UPPERS							
U. R. Central	Cervical	1.1	1.4	.20	.20	.90	.3 yel.
	Incisal	1.1	1.35	.34	.34	.76	.25 "
" Lateral	Cervical	1.85	2.9	1.3	1.3	.55	1.05 "
	Incisal	1.85	2.7	1.7	1.7	.15	.85 "
" Cuspid	Cervical	1.85	3.3	1.75	1.75	.10	1.45 "
	Incisal	1.9	3.1	1.85	1.85	.05	1.2 "
" 1st bicuspid	Cervical	2.0	2.7	1.6	1.6	.40	.7 "
	Incisal	2.0	2.6	1.7	1.7	.30	.6 "
" 2nd "	Cervical / Incisal	2.0	2.3	1.6	1.6	.40	.3 "
" 1st molar	Cervical / Incisal	2.4	3.7	2.3	2.3	.10	1.3 "
U. L. Central	Cervical	1.1	1.5	.20	.20	.90	.4 "
	Incisal	1.1	1.4	.38	.38	.72	.3 "
" Lateral	Cervical	1.85	2.9	1.3	1.3	.55	1.05 "
	Incisal	1.85	2.5	1.6	1.6	.25	.65 "
" Cuspid	Cervical	1.95	3.2	1.75	1.75	.20	1.25 "
	Incisal	2.0	3.1	1.8	1.8	.20	1.1 "
" 1st bicuspid	Cervical / Incisal	2.0	2.7	1.6	1.6	.40	.7 "
" 2nd "	Cervical / Incisal	2.0	2.3	1.6	1.6	.40	.3 "
" 1st molar	Cervical / Incisal	2.4	3.6	2.3	2.3	.10	1.2 "
LOWERS							
L. R. Central	Cervical	1.0	2.5	.74	.74	.26	1.5 "
	Incisal	1.0	2.4	.76	.76	.24	1.4 "
" Lateral	Cervical	2.4	3.4	1.6	1.6	.80	1.0 "
	Incisal	2.3	2.9	1.8	1.8	.50	.6 "
" Cuspid	Cervical	2.6	3.3	1.5	1.5	1.1	.7 "
	Incisal	2.3	2.7	1.55	1.55	.75	.4 "
" 1st bicuspid	Cervical / Incisal	2.0	2.5	1.5	1.5	.50	.5 "
L. L. Central	Cervical	1.0	2.5	.74	.74	.26	1.5 "
	Incisal	1.25	2 4	.95	.95	.30	1.15 "
" Lateral	Cervical	2.4	3.4	1.6	1.6	.80	1.0 "
	Incisal	2.3	2.9	1.8	1.8	.50	.6 "
" Cuspid	Cervical	2.4	3.1	1.45	1.45	.95	.7 "
	Incisal	2.2	2.6	1.5	1.5	.70	.4 "
" 1st bicuspid	Cervical / Incisal	2.0	2.5	1.5	1.5	.50	.5 "



Depths of colors in the necks of the upper anteriors.



Depths of colors in the incisal halves of the upper anteriors.

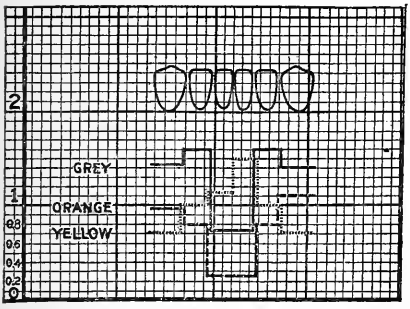
DIAGRAMMATIC REPRESENTATION OF THE DEPTHS OF COLOR TABULATED ON PAGE 66.

The different depths of color in different parts of a tooth and in different teeth can be diagrammatically shown in charts like those here reproduced.

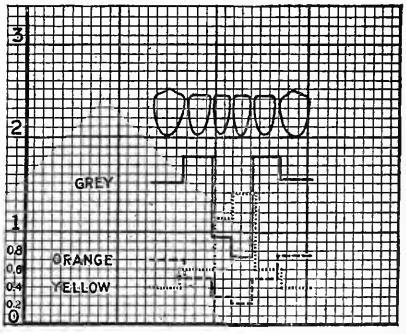
The horizontal base line of the charts represents 0 in color. Each of the parallel horizontal chart lines represents a depth of 1-10 of a unit, upward from 0. The line locating the gray in the teeth is drawn solid. That representing the orange is drawn in dashes and that representing the yellow, in dots. This set of teeth showed no other colors. This person's hair is dead black, the eyes are brown, and the skin showed a good deal of red.

The charts show that the necks of the upper centrals and laterals in this set exhibit less gray than the cutting edges, but more orange and yellow. The cuspids exhibit practically the same amount of gray and orange throughout the teeth, but the necks show more yellow than the cutting edges. This free yellow gives these cuspids their character.

The necks of one lower central and both lower laterals in this set, exhibit less gray than the cutting edges, but the necks of the lower laterals exhibit more orange and yellow. The lower cuspids exhibit practically an even depth of gray throughout, but much more orange and yellow in the necks. There is a good deal more orange in the lower cuspids than in the upper cuspids.



Depths of colors in the necks of the lower anteriors.



Depths of colors in the incisal halves of the lower anteriors.

Illustration No. 32

Some of the difficulty of that work may be understood when I tell you that it has taken two years to gain the necessary information, and that in addition to our own efforts from one to three experts have been working steadily. They state that they never saw such difficult and delicate work, nor such exacting taskmasters as we have proven. However, we have gotten at least the greater part of what we want and have incorporated it into Trubyte Teeth.

Let me set before you some facts regarding the distribution of colors in different anterior teeth. Let us take as a shade in which to work, Twentieth Century shade 7. The color in the upper central will be found distributed about as it is in the shade tooth, because the manufacturers seem to have paid pretty close attention to the shading in the upper centrals, and to have imitated it pretty well. **Their error consists in the fact that they have applied this form of shading to all the anterior teeth.**

The shading of the upper laterals is very much like that of the upper centrals in depth, but the incisal third of the lateral is darker. This does not seem quite logical in view of the fact that the incisal half of this tooth is largely composed of the enamel plates, with only a small amount of dentine. But I have the analyses, the charts and the color drawings before me as I write, and they indicate that **the incisal half of the upper lateral has more color than the same portion of the upper central.** It is especially distinguished by the presence of more gray.

The cervical half of the upper cuspid shows more color than the cervical half of the upper central or lateral, while the cuspid shows the widest variation in individual teeth, and that without any apparent relation to the color in the incisal halves of the central and lateral. It has, of course, always been known in a general way, from observation, that the cuspids were darker than the centrals, but there has never been any exact knowledge about the conditions of this variation.

The depth of color in the lower anteriors, as compared with the depths of color in the upper anteriors, differs markedly in different individuals and apparently in different races. I think a fair statement of it would be that **the colors seen in the upper teeth are slightly deeper in the lower anteriors.** The cutting edges are also generally deeper in color. This makes the color throughout each tooth in the lower anteriors more uniform. The effect of the deeper average of color and of the uniformity affords a pleasing contrast with the upper teeth.

VARIATIONS OF COLOR IN NATURAL TEETH

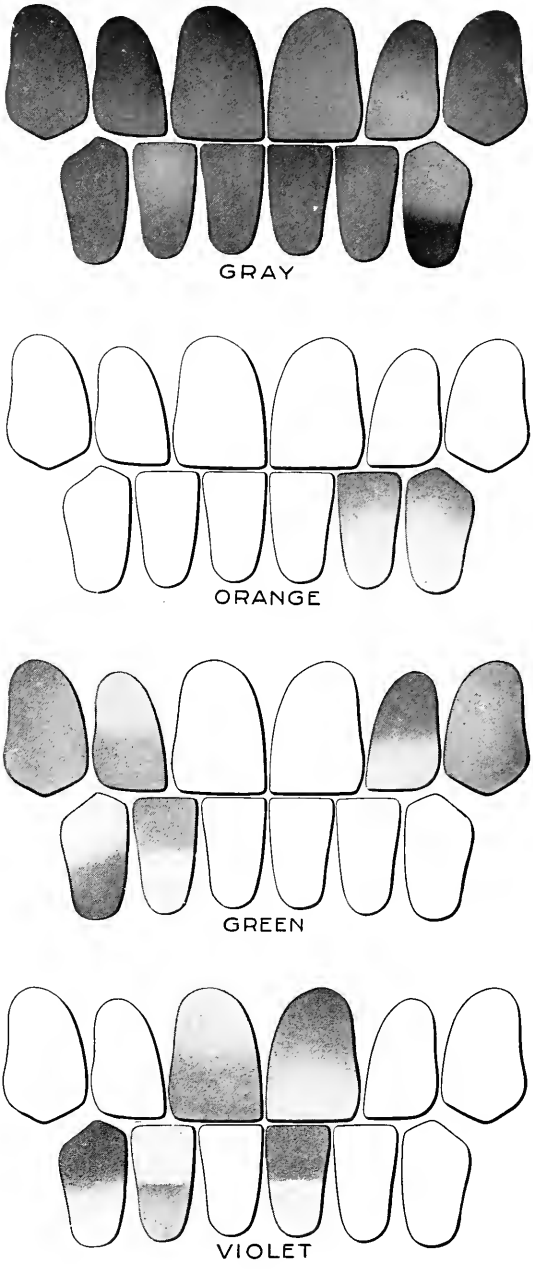


Illustration No. 33

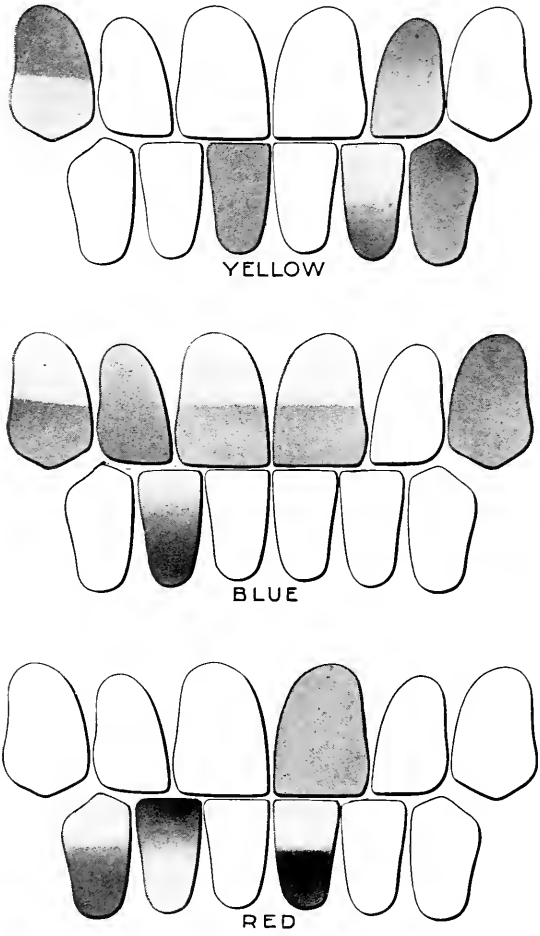


Illustration No. 34

These color effects have been achieved in Trubyte teeth by placing the dentine and enamel bodies in such way as to reproduce the natural variations. This has been made possible by the translucency of the porcelain from which these teeth are made.

These colors can be properly placed only by people especially trained and by allowing them much more time than is required for shading the ordinary porcelain teeth of commerce. This necessarily increases the cost of the teeth, but this increase in cost is trifling when the advantages gained are considered.

The results attained in coloring Trubyte teeth are superior to those which will ordinarily be accomplished by staining and burning teeth by the individual dentist. The colors are in the teeth, are the result of proper placing of the dentine and enamel bodies, and are under the glaze. The results are an enormous stride in advance of what has been heretofore commercially offered.

One who has not closely studied the colors in natural teeth can hardly realize how delicate and beautiful is the color scheme by which nature adorns a really fine set of teeth. The primary colors, red, blue and yellow are, as one who has made a scientific study of color would expect, found in every human tooth. The blending of these primary colors produces the secondary colors—the orange, green and violet. It is very interesting to note the parallelism of form and color in teeth as elsewhere in nature.

As one or other of the three primary types of form is usually dominant in every upper central incisor, and to a certain degree in every human tooth, so one or other of the three primary colors is generally dominant and a **color expert might classify most human teeth as pink, blue or yellow.**

As much the larger proportion of teeth are, in form, the result of the crossing or blending of the primary forms, so also in color the blending or mixing of the primary colors produce a great variety of secondary or intermediate colors in which orange, green and violet are clearly seen.

It is a rare thing to find two teeth in any given mouth of exactly the same color. Just as it is rare to find a pair of teeth on different sides of the mouth of the same shape. It is these slight variations in form and color which give great beauty, harmony and naturalness to a fine set of natural teeth, and it is mechanical regularity in form and sameness in coloring which make artificial teeth, as they have heretofore been made, so false looking, so unnatural and repulsive.

As a more detailed account of the results of our investigation into the color of natural teeth will shortly be published in book form * and offered to the profession, I shall give here but a brief resumé of this work. The table on page 66 gives a color analysis, according to the scientific method we have followed, of a single set of natural teeth, and on the following page will be seen a diagrammatic representation of the depths of color in the incisors according to the table.

The first three columns in the table show the percentages of the standard colors used to determine or develop the actual colors in the tooth which are indicated in the three columns on the right.

When I tell you that for every figure set down in those columns a considerable number of trials with optical apparatus of the most exacting nature had to be made before the final result was reached, you will, I think, begin to understand why this work could not be completed quite as rapidly as some of our impatient confreres thought, and also why a slight advance in the cost of these teeth has been necessary. **Trubyte teeth, as I have said, are "shaded" on the basis of this investigation into the color of natural teeth.** The upper central is always of the shade on the guide. This is the *dominant* color of the set the shading of which is accomplished by varying the depth of this color. The color in the upper laterals is more evenly distributed throughout the tooth just as we find it in nature.

The upper cuspids are more deeply shaded in both cervical and incisal halves than either the centrals or the laterals. The color in the bicuspids and molars is slightly deeper.

The color in the incisal halves of the lower anteriors is slightly deeper than in the incisal halves of the uppers.

For the first time in the commercial history of porcelain teeth they are now supplied to the dentist of a color closely approximating that found in natural teeth. The color, being based on nature, gives a far finer effect than the arbitrary method of hand staining or the still more imperfect method of selecting a variety of colors from different sets and assembling them into one.

Dentures made with teeth shaded in this natural way are, artistically, so superior to those made of one shade that a comparison cannot well be made.

In form, in surface texture and in color the Trubyte System of teeth has reached such a high standard of achievement that I hope and believe the finest artistic and mechanical ability in our profession

* Prosthetic Articulation.

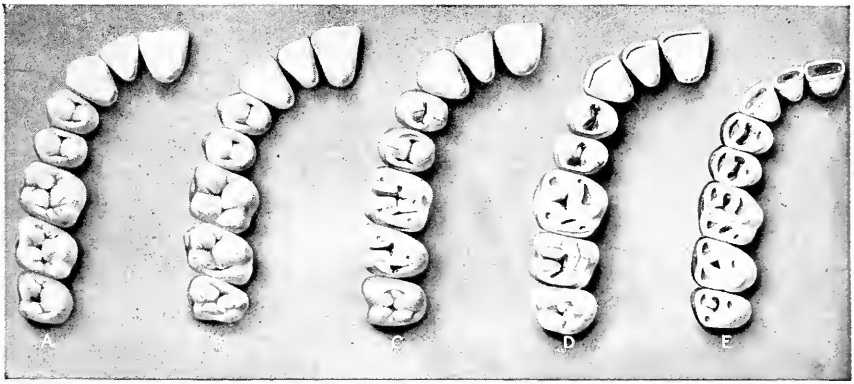


Illustration No. 35

Five Stages of Wear of Natural Teeth: A. Unworn Stage. B. Greatest Efficiency Stage. C. Reduced Efficiency Stage. D. Much Worn Stage. E. Stage of Extreme Wear. Trubyte teeth exhibit the stage of wear shown in Figure A and the depth of bite shown in Figure B.

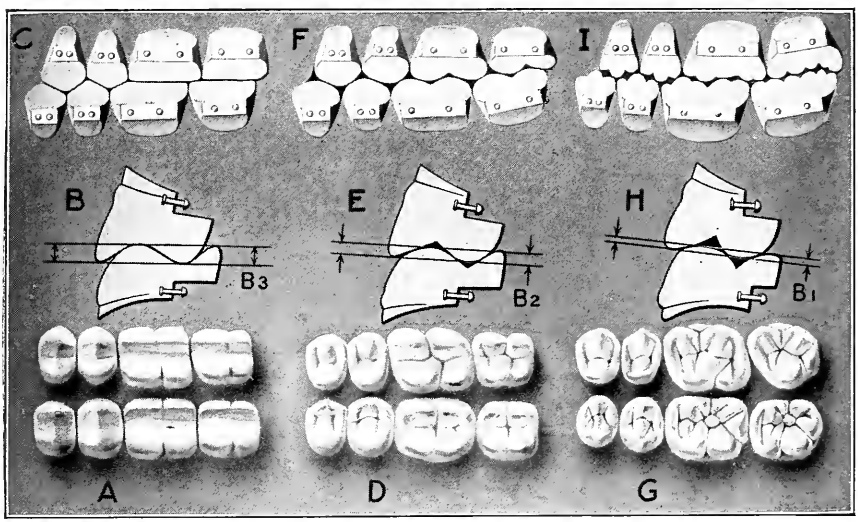


Illustration No. 36

Figure A shows occlusal surfaces of upper and lower molars ground to articulating form after method formulated by Dr. Bonwill.

Figure B shows same molars occluded.

Figure C shows longitudinal section of same teeth.

Figure D shows the same occlusal surfaces of the anatomical moulds of the Dentists' Supply Company. These are carved to much more nearly correct anatomical form than were the teeth of Dr. Bonwill's time.

Figure E shows molars occluded. The longitudinal groove is entirely different in character from that shown in Figure B. The upper buccal cusp does not overhang the lower molar as in Figure B. The depth of bite in these teeth is only half as great as in those shown in Figure B.

Figure F shows a longitudinal section of the same teeth.

Figure G shows the occlusal surfaces of Trubyte teeth, with the formation for cracking, tearing and cutting.

Figure H shows Trubyte first molars occluded.

Figure I shows a longitudinal section of these teeth. Instead of presenting the flat opposed surfaces shown in Figure C or the single convex surfaces shown in Figure F, these teeth exhibit from two to five grooves and from three to six cusps each.

will be aroused by their appearance and stimulated to the production of such results as have never before been known in the history of dentistry.

TRUBYTE BICUSPIDS AND MOLARS.

And now I come to a part of the paper which describes mechanical advances of such importance to the dentist and to the patient as a masticating animal, that, from this point of view also, it will hardly be possible to exaggerate the advantages of the new teeth. I refer to the greatly improved forms of the masticating surfaces of the bicuspids and molars perfected by my associate, Professor Dr. Gysi.

Professor Gysi has established the fact that proper forms of porcelain bicuspids and molars cannot be produced by copying natural teeth, because **at no time do the natural teeth present all the characteristics essential to artificial teeth.**

It is logical that this should be so. The natural teeth are fixed in the jaw. In adult life they are capable of a masticating force of from 100 to 300 pounds, with perhaps an average of 150 pounds. In early life they exhibit deep bites and great efficiency. In later life they exhibit relatively flat bites and require the exercise of great force to make them efficient.

Artificial teeth on dentures are not firmly fixed in the mouth and on bridges are less firmly fixed than when each tooth has its own healthy root. Dentures are believed to be capable of exerting a pressure not greatly in excess of 15 pounds, perhaps 20 or 25 pounds as a maximum, as compared with the 150 pounds of the natural teeth. Bridge teeth are capable of exerting less power than individual, healthy natural teeth.

Artificial teeth, then, with one-tenth the power of the natural teeth, must discharge the same functions as the natural teeth, or the food cannot be properly prepared for digestion. They must exhibit shallow bites in order that the dentures or the bridge may not be subjected to severe lateral strains. Teeth which will function efficiently and be stable under such conditions cannot be formed by copying natural teeth, which were designed to function under very different conditions. They can be made only by applying engineering principles to the designing of surfaces which shall function under actual conditions, just as the engineer designs his bridge for the load it must carry.

In the brief space of time left me, I shall draw your attention to the application of these engineering principles only for the accomplishment of some of the greater objects sought in Trubyte bicuspids and molars. The points are:

Proper opening and closing articulation in bicuspids.

Proper sliding articulation in the molars.

High cusps, deep fossæ and sulci with shallow bites.

A large number of properly interacting facets on the occlusal surfaces of the molars.

Precisely as I have followed the general natural form in designing the Trubyte System so Dr. Gysi has based the forms of his masticating surfaces on nature, but he has greatly improved on Nature in efficiency of mastication as I have improved on form.

PROPER OPENING AND CLOSING ARTICULATION IN BICUSPIDS.

Artificial bicuspids have heretofore been merely little molars. They have exhibited the same form of sliding articulation as the molars. This is anatomically incorrect and deprives the patient of the benefits to be derived from the very important functions of the bicuspids. Their functions are to catch, hold, and crack brittle foods, and to pierce between fibers which have been placed along them and are being held by the sliding articulation of cuspids and molars.

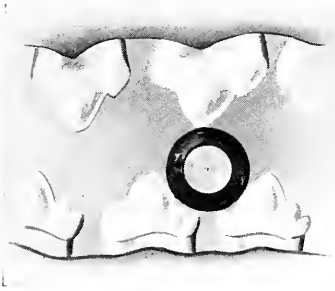
Bicuspids can discharge these important functions only by exhibiting an opening and closing articulation while the cuspids and molars are in sliding articulation. Trubyte bicuspids exhibit this most important form of Articulation.

PROPER SLIDING ARTICULATION IN THE MOLARS.

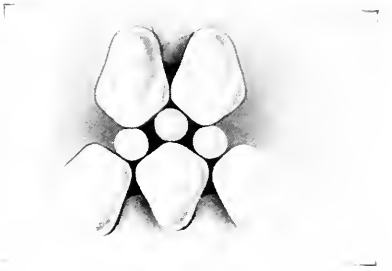
The articulation desired in the molars is entirely different from that in the bicuspids. When the teeth in the lower jaw come up against those in the upper, with food between them, the buccal and lingual cusps should interdigitate to prevent the escape of solid food, and as the jaw returns to the position of central occlusion, **the opposing upper and lower cusps should maintain a certain form of sliding articulation.** This form of articulation is very different in character from that heretofore possible to porcelain molars.

Porcelain molars which have heretofore been offered have articulated by the sliding of one cusp past another. This is effective to a certain degree, but not sufficiently so to render porcelain teeth efficient under the small pressure which they can exert. It is necessary to the maximum of efficiency that each of these cusps should cut across the opposing cusp in much the same way a barber draws a razor across a strap, or like the action of the figures shown in Illustration No. 38.

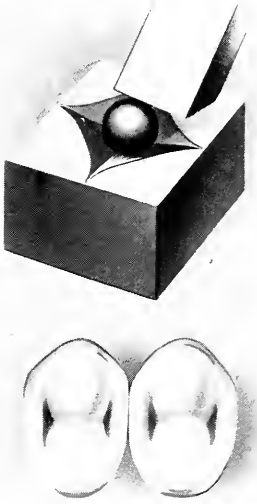
This action greatly increases the cutting efficiency of the teeth by causing each ridge to cut throughout its length, instead of for a short distance only.



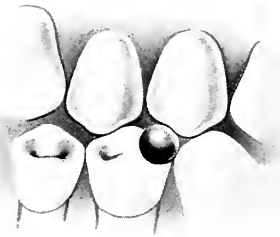
The bone cracking teeth of the dog.



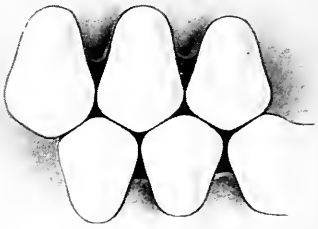
Similar cracking action by human bicuspids.



Diagrammatic representation of a grain trap. Same trap in Trubyte bicuspids.



Buccal cusps interdigitate in articulation.



Lingual cusps open to receive seeds and grains.

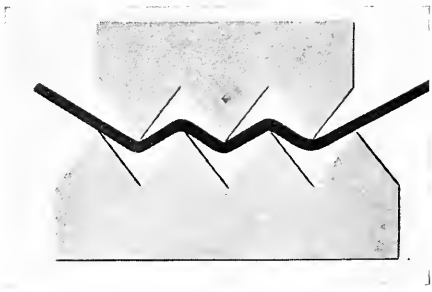


Diagram of tearing action.

Illustration No. 37

The formation of cusps for such interaction is possible only by the application of engineering principles. I have seen the formulæ and the methods by which Professor Gysi has arrived at these results, and they are as complicated as the designing of a cantilever bridge. The action of each part of each tooth has been known before an instrument was taken in hand for the carving. It is the highest form of praise to say that **the resulting teeth are as near to the theoretical results as anything in porcelain can be.** They set up easily and function efficiently.

It must not be thought that because I have quoted Professor Gysi as to the application of engineering principles to the formation of these surfaces, nature's laws have been departed from, and unnatural forms produced. Such is not the case. Nature is the most consummate engineer of us all. She adapts her forms to function with the exercise of the smallest possible force, and with the least disturbance of parts.

The laws which she employed for the formation of the permanent teeth and which made them efficient with the relatively small masticating force of the child have been employed. **The depth of bite has been reduced so that it is** much more shallow than in efficient human teeth, and **only half as deep as in the present anatomical moulds.**

The ridges have been arranged to present the longest cutting action possible and to bring into action a large number of small surfaces, interacting properly, in order that the food may be more thoroughly masticated. The forms of these ridges have been carefully designed by applying the laws exhibited in human teeth at the period of their greatest masticating efficiency.

I have been asked whether teeth so accurately formed can be set up by the average dentist. In reply let me say that **they can be better set than any other and less accurate forms.** They cannot always or perhaps often be articulated for individual peculiarities of jaw movement without some small amount of grinding, but this grinding can be done with the carborundum and glycerine, and will be neither tedious nor difficult. Little or no grinding with a stone should be necessary.

Improved Formations in Cuspid Edges.

Both Dr. Gysi and myself have contended from the first that the highest success in the making of artificial teeth cannot be reached by baldly copying natural teeth.

Dr. Gysi makes the same claim from the point of view of efficiency in mastication. He has originated a phrase that will become classic in prosthetic dentistry which is that "the problem of restoring mastication is an engineering problem."

The cutting edges of the cuspids present the most anterior example of the application of engineering principles. For these edges must be quite differently formed in porcelain teeth than they are in newly erupted natural teeth.

Natural upper cuspids are often very beautiful in form, and before wear has mutilated them, present long and often pleasing cusps. These are the forms which have generally been reproduced in porcelain teeth. They are the forms which have made it practically impossible to arrange the upper and lower cuspids properly, without extensive grinding of the edges. Many find this grinding difficult of accomplishment.

The edges of the upper and lower cuspids here shown have been shaped to function properly. The anterior facet on the edge of the lower cuspid is always short, so that it may occlude with the distal facet on the cutting edge of the upper lateral. **The mesial facet of the upper cuspid is usually long,** in normal dentures after wear, in order that this tooth may both occlude and articulate with the lower cuspid, and that the point of the upper cuspid may pass through the interdental space posterior to the lower cuspid and not climb on the lower. This is one of the most important relations in the articulation of dentures, and has heretofore been one of the most difficult to attain. The fact that it may easily be attained with Trubyte teeth will greatly facilitate the arrangement of these teeth and their efficiency in mastication.

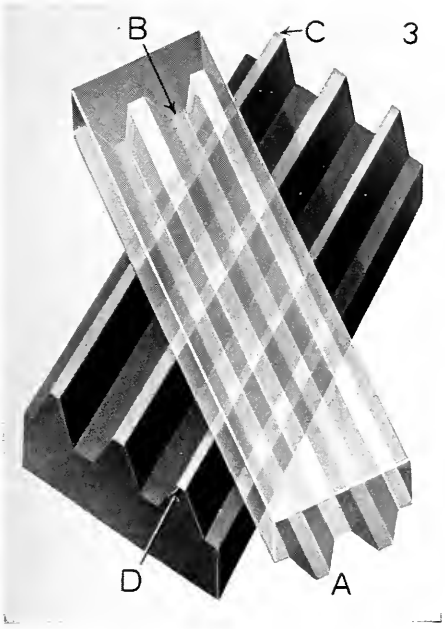
SUMMARY.

A brief summary of the facts and principles involved in this system of artificial teeth:

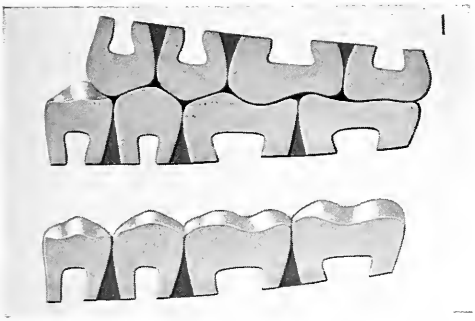
1st. This system is based on the new classification of the natural teeth which I have discovered, the essential feature of which is the three primary or primitive forms of the upper central incisors common to all races of men and the anthropoid apes.

2d. By the crossing or combining of these primary forms **every conceivable form of human tooth can be produced.**

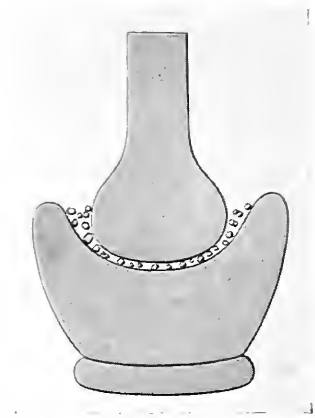
3d. By applying a knowledge of design to the three primary forms of natural teeth a system of teeth has been produced in which **all the lines and contours of any given set are in more perfect harmony and balance than we usually find in Nature.**



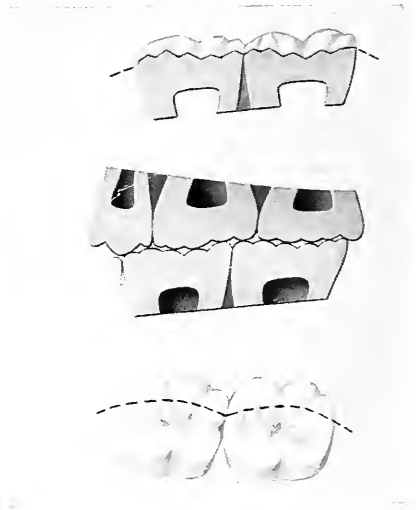
Diagrammatic illustration of the cutting action exhibited by opposed ridges and facets in Trubyte molars. If the point A of the upper block be carried to the point C of the lower block, and then the upper block be so moved as to bring the point B directly over the point D of the lower block, each of the opposed ridges will cut throughout its length with a drawing motion. This is the longest and most efficient "cut" possible to these ridges.



Diagrammatic representation of the plan on which artificial molars have generally been shaped in the past. The broad surfaces cannot cut up foods to isolate the cells. They can be approximated only by the exercise of great force.



Food cells are isolated and the cell walls broken by the rubbing together of the facets. The rubbing action is diagrammatically shown by the mortar and pestle in which substances are pulverized.



A. A cross section of Trubyte lower first and second molars showing five ridges in each tooth. B. Ridges and facets in Trubyte upper and lower molars opposed. C. The cross sections shown above were made at the dotted line in this figure.

4th. As the three primary forms of human teeth are common in all races, therefore a system of artificial teeth founded on these primary forms is **equally suitable for all races of men civilized or savage.**

5th. As investigation shows that there are but a few characteristic forms of human faces which can all be grouped in a series of a dozen or less, to which groups all slight variations in form may be referred, therefore **a few forms or types of teeth,** very carefully designed and modeled to harmonize with the more characteristic forms of faces, **are immeasurably better suited to the production of natural and artistic effects in dental prosthesis than any number of moulds produced indiscriminately** and without any knowledge of the above-mentioned fundamental facts.

6th. A close study of the relationship of the contour lines of the teeth and face has enabled me to design artificial teeth that **will be found to give more perfect harmony with many faces** than did the natural teeth of that subject, the reason for this being that the laws of heredity as exhibited in mixed races rarely permits a perfect harmony in the different features of the body.

7th. The arrangement of this system of teeth into classes and groups based on Nature and corresponding with the forms of faces for which they are designed, both being shown in illustrations placed side by side, enables the dentist, aided by the very clear and simple table of classification, to select the teeth best suited for any case with an ease, economy of time, and certainty of results never before approached.

8th. A method of finishing the labial surfaces of the plaster models for artificial teeth, and the accurate transfer of this to the moulds in which the teeth are cast, has been devised with the result that **a perfect imitation of the surface texture of a fine natural tooth has been secured.** The esthetic value of this one feature of the new system of teeth is sufficient to merit the indorsement of all progressive dentists.

9th. **A method of coloring porcelain teeth has been worked out by strictly scientific methods,** based on a color analysis of the finest natural teeth, and applied to the Trubyte System of teeth, producing beautiful natural effects far beyond anything previously accomplished.

10th. My associate in the work of producing the Trubyte System of teeth, Professor Dr. Alfred Gysi, has given years to the study of the mechanical principles involved in mastication and to all the conditions necessary in artificial teeth for the highest possible efficiency in the performance of this function. Basing his work entirely upon nature, as I have in designing the forms of teeth, he has recognized that the conditions under which mastication must be performed with artificial teeth are totally different from those which obtain in the use of natural

teeth. He has therefore adapted the natural cusp, groove and sulci formation in the relations of the upper and lower teeth in such a way as to secure far greater efficiency in mastication than would be possible even with the finest natural teeth if inserted on plates as artificial dentures. While the cusps are high and the fossæ and sulci deep in the new teeth, thus making them very effective in holding, tearing and grinding food, yet the "bite" is actually more shallow than in efficient natural teeth or in other porcelain teeth which manifest even slight efficiency. This permits easy and comfortable gliding of the upper and lower teeth on each other in lateral and in backward and forward movements.

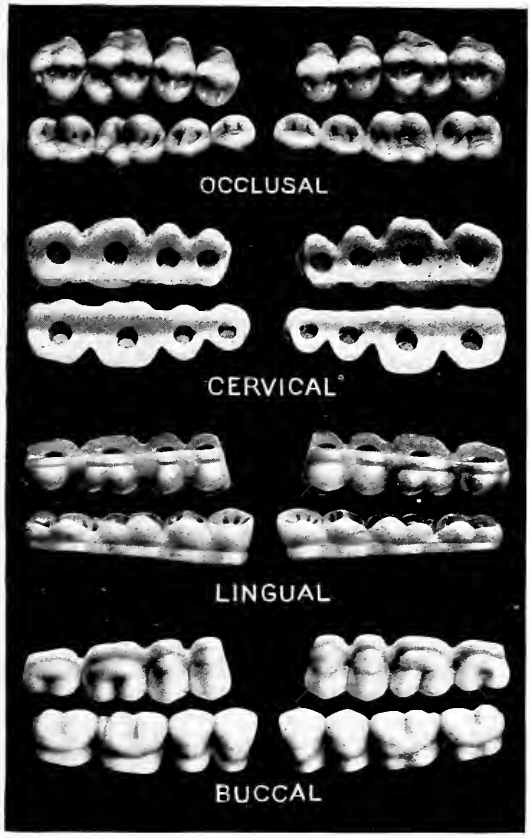
With all of these advantages of scientific form and accuracy in all their features the new teeth will be found, when the dentist is once accustomed to them, more easy to arrange on any form of articulator than any teeth heretofore made, the perfection of the relations of the upper and lower teeth showing at once exactly where they should be placed.

Gentlemen, speaking not only for myself, but for all who have taken part in this work, I am expressing my most sincere convictions, when I say that no more concentrated and determined effort has ever been made in the interests of dentistry than that involved in this new system of artificial teeth.

Scarcely more than the bare results and conclusions could be embodied in this presentation of the subject. A detailed account of all the experiments made, of all the scientific work done during the past four or five years, would fill a large volume.

It has been our firm determination to do this work so well that it should be done for all time. It has been our desire and intention to set the standard of prosthetic dentistry so far above the position it has hitherto occupied as to make it impossible from this day henceforward for any self-respecting dentist to continue working in the old ways and with the old materials.

MOLAR BLOCKS.



Dr. Gysi has invented a new form of bicuspids and molars which I feel sure will be found most convenient in practical work. He calls this form Molar Blocks, because the bicuspids and molars of each side are joined into a solid block.

The Molar Blocks differ in very important ways from the gum blocks to which many of us have been accustomed. Those gum blocks were designed for occlusion but not for articulation, and it is pretty nearly impossible to articulate them. These Molar Blocks are designed to facilitate articulation, and to that end Dr. Gysi has worked out the compensating and lateral curves in the occlusal surfaces, so that when set in the occluding position the work of articulating the teeth is already well advanced.

Dr. Gysi states that it is most advantageous to offer these blocks in the curves common to the average inclinations of the condyle paths, because a slight inclination of the entire blocks adapts them to any greater steepness of curves.

These blocks may be articulated in much less time than single teeth. It is much easier to perfect the articulation in its finer details, because single teeth cannot move out of position, and because the proper relations of the several teeth are already determined.

The occlusal surfaces of these blocks exhibit the same characteristics as the single teeth and are efficient in the same unusual degree.

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